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## MIMETIC ANALOGY.

BY W. B. TEGETMEIER.

*(With a Coloured Plate.)*

THE theory of mimetic analogy is one that endeavours to account for a large and extensive series of phenomena that have long been known to observant naturalists. The phenomena themselves are indisputable, but hitherto no satisfactory explanation has been offered to account for their existence.

By mimetic analogy is meant the fact that one animal often possesses a very close resemblance to some other animal, which is most frequently of a very distinct group. Sometimes the object mimicked is an inanimate one—a stone, a bud, a leaf, or a broken twig. Instances of this latter kind of resemblance are so common as to strike even the most casual observer. The greater number of animals assume more or less closely the colour and appearance of the objects with which they are generally surrounded. Thus reptiles, such as frogs, snakes, etc., living on the ground, resemble the colour of objects on the earth's surface; whereas the tree-frogs are usually of a bright green colour, in accordance with the leaves amongst which they spend their lives. Even in birds of bright showy plumage, in which this assimilation of colours would hardly ever be suspected, it frequently prevails. Thus in the beautiful little Australian warbling parrakeets, known generally in this country by the aboriginal name of Betcherrygar, the resemblance of the colour to that of the leaves of the Eucalypti, or Gum trees, on which they repose during the mid-day heat, is so close, as Mr. Gould informs us, that though dozens may be perched on a branch, they are hardly to be observed when at rest. Among our own insects the imitation of inanimate objects is not unfrequent: the common buff-tip moth is a familiar example, as when at rest it closely resembles a piece

of broken lichen-covered twig, the end of which is simulated by the tips of its closed wings.

Nor is the imitation of natural objects confined to a few species: it has been noticed in entire groups, and even in the whole insect fauna of a country at particular seasons. In an interesting note on the autumnal and winter moths of England, published in the *Zoologist* for 1856, the Rev. Joseph Greene, one of our most accurate entomological observers, writes:—

"I am not aware whether any entomologist has ever been struck by the singular adaptation and similarity of colouring in the autumnal and winter Lepidoptera to the prevailing tints of nature during these seasons. Counting from the middle of September, when the leaves begin to turn, to the end of February, we find among the Bombyces, Noctuæ, and Geometræ, about fifty-eight species on the wing. Now in the autumn the hue of nature is golden—she passes through all the intermediate stages from pale yellow to a deep rich brown; while in winter she assumes a grey or silvery garb. Taking those fifty-eight species, we find in their prevailing colours a striking and remarkable similarity to those which nature assumes at the time of their appearance in a winged state. Three species are doubtful, seven militate against my theory, the remainder are decidedly in my favour."

The writer then proceeds to enumerate the autumnal species, which are yellow or rich brown, and the winter species, which are grey or silvery, and concludes:—"It certainly strikes me as a very interesting fact, showing the hand of an Almighty and Allwise Being to be visible in this as in all the other works of the Creation."

It must not be imagined that these imitations are confined to the invertebrate animals or the lower forms of life. Among the warm-blooded vertebrata the examples of mimetic analogy are not wanting. Thus the grey-banded cuckoos so closely resemble hawks, both in appearance and flight, that they are constantly mistaken for them in all parts of the world, and this not only by the natives, but by the smaller birds of the several countries.

One of the most amusing instances of this close similarity of birds of very different groups is related by Mr. G. S. Taylor in his account of the "Birds of Honduras," published in the *Ibis*. Describing a large hawk, he writes:—

"I call it the 'Curassow Hawk' (*Ibycter americanus*), from its resemblance to the curassows, and to commemorate the following adventure:—While at Tauleri I was out one evening with my gun, and was returning home with a small trogon which I had shot, when I met Mr. Edwards, who pointed out to me some large birds sitting on a tree, which he said were

curassows. There were five of them; and they certainly did look like curassows in flight and general appearance. The plantain patch was thickly overgrown with long grass and weeds; but on I went, regardless of probable snakes and certain swarms of agarrapatas, although I had been particularly careful all day not to go where I was likely to carry any off. As for the trogon I threw it away in contempt, having much finer game in view. The curassows I thought would amply repay me for a sleepless night, endless scratching and consequent sores; so I stalked up to them and shot one, while the others flew off to a not very distant tree. From their flight, cries, and general appearance, I still thought they were curassows. The bird I killed fell into a dense thicket across a stream. Could I only have got it, I should have been spared additional agarrapatas and disappointment. However, not stopping to pick up the dead one, I followed the others across the plantain patch, then forced my way through an aloe fence, which presented a perfect *chevaux de frise* of spikes, and succeeded in shooting three out of the remaining four. I now felt proud of what I had done, and how well I had provided for our pot, which was in great want of supplies at the time. Edwards, who had been waiting for me, went to pick the birds up. As he took hold of the first, he said 'this is a hawk;' and hawks they all were, sure enough, to my great disgust and disappointment. When dead they still much resembled curassows, but were hawks nevertheless—nothing but great black, striking, red-legged hawks. However, I was not disappointed in agarrapatas, for I went home well stocked with them, and in no pleasant humour at having little or nothing to repay me for the discomfort I had to undergo."

It may perhaps be asserted that these imitations are rather general, and, as it were, accidental, than particular and designed; I will, therefore, quote from the *Transactions* of the Zoological Society, a much closer and more remarkable example of mimicry, described by Mr. Wallace, who, when speaking of the birds newly discovered by himself in the Mollucca Islands, observes, "that two species of the Oriolidæ, natives of Bouru and Ceram, departed altogether from the natural appearance of the group, and mimicked two species of Honeysuckers so closely as to deceive ordinary observers." Speaking of the birds inhabiting Bouru, he writes, "the oriole has departed from the usual gay colouring of its allies, and is actually the dullest coloured of its family, while the honeysucker that it imitates very much resembles in its colouration other species of the group to which it belongs. The imitation is carried to the minutest particulars; the black orbits of the honeysucker are copied by a patch of dusky feathers around the

eyes of the oriole, and even the very peculiar ruff of recurved feathers on the nape of the former, has its general effect imitated by a collar of pale colour in the latter. The under and upper surfaces of the two birds are as near as possible of the same tint respectively, and, stranger still, the oriole has closely copied the mode of flight and voice of its model, so that in a state of nature the two birds are practically undistinguishable."

"This curious instance," states Mr. Wallace, "does not stand alone, for in the adjacent island of Ceram, two allied but very distinct species resemble each other with equal accuracy."

With regard to the object of this imitation, Mr. Wallace proceeds:—"In the case of insects it seems probable that it is the odour or the taste of the imitated species which is unpalatable to insect-eating birds; or, in other cases, like the clear-winged moths, which mimic Hymenoptera, the species mimicked are armed with a sting. In birds, it is evidently the bravest, strongest, and best armed groups should be the subjects of mimicry, and the weakest and most defenceless which should obtain some advantage by imitating them.

"Returning to the oriole and the honeysucker, we have to observe that the former is a smaller, weaker, less active, less noisy, and less pugnacious bird. The feet have a less powerful grasp, and the bill is less acute. The latter has a great variety of loud and piercing notes, which bring its companions to the rescue in time of danger. And I have observed them drive away crows, and even hawks, which had ventured to perch on a tree where two or three of them were feeding.

"The honeysucker knows how to take care of himself, and make himself both respected and feared. It would, therefore, evidently be to the advantage of the more defenceless oriole to be mistaken for him.

"In this instance, as in most others, the imitation is far closer in the living bird than in the dead specimens. This is a far more satisfactory case of mimicry than any of those which I have before alluded to as occurring among birds. We have here two species, each confined to single islands, and each accurately imitated by a bird of a distinct family, with which it has no direct affinities. I therefore cannot doubt that this is a true case of mimicking exactly analogous to that so common among insects."

The most remarkable cases of mimetic analogy with which we are acquainted are those found amongst the butterflies of the valley of the Amazon. These cases have been investigated with great care by Mr. H. W. Bates, and the results published in the twenty-third volume of the *Transactions* of the Linnean Society.

Among the most numerous butterflies of this South American region are various genera and species belonging to the family of Heliconidæ. The species, wherever they occur, are described by Mr. Bates as being exceedingly abundant in individuals; they show signs of flourishing existence, although of slow flight and feeble structure, and apparently unfurnished with any means of defence, although living in districts abounding with insect-eating birds. So numerous are they that the pathways in the forests are rendered gay with the multitudes that fly about among the trees in their bright dresses of orange, blue, yellow, red, and black. Some species of these fine showy butterflies are described by him as assembling together in small parties like our gnats, or by twos and threes, to sport together and perform a kind of mazy dance. The sport generally begins with a single pair; they advance, retire, glide right and left in face of each other, wheel round to a considerable distance, again approach, and so on; then a third joins in, and then a fourth, and so on, until a large party is assembled. They never touch; but when too many are congregated a general flutter takes place, and they all fly off to fall in again by pairs shortly afterwards.

It is noticed that wherever large numbers of any of these Heliconidæ abound, they are always accompanied by species which closely mimic them in size, form, colour, and marking; and these resemblances are so close that it is often impossible to distinguish one species from the other when they are on the wing, as the imitators fly in the same part of the forest, and go usually in company with the species they imitate. To so wonderful an extent is this imitation carried, that, in cases where there is a local variety of a species of the family Heliconidæ, the butterfly imitating that particular species changes so as to follow the variations of its model.

It may be asked if two butterflies, of totally distinct groups, and having different structures, thus closely resemble one another, how can it be known which is the imitator and which the imitated? The answer to this question is sufficiently easy. The objects imitated preserve the form and likeness peculiar to the family to which they belong; but the imitators are of a different aspect to their nearest allies. Thus when a clear-winged moth is found, having a close resemblance to any species of bee, we have no hesitation in saying that the moth, having departed from the usual aspect of its group, has imitated the bee, which remains like its congeners, and not that the bee has imitated the moth. Or, to take the examples shown in our coloured plate, we are justified in assuming that the different species of Leptalis, shown in the Figures 2, 3, and 4 in our coloured plate, are the imitators, because they have

departed from the proper normal form of the genus Leptalis, which is shown at Figure 1, representing *L. Nehemia;* whilst the Heliconidæ figured, belonging to the genera Ithomia and Methona, are the imitated, because they resemble their nearest allies. Hence we regard *Leptalis Theonoë*, var. Leuconoë, Fig. 2, as imitating *Ithomia Ilerdina*, Fig. 2A; *Leptalis Orise*, Fig 3, as imitating *Methona Psidii*, Fig. 3A; and *Leptalis Theonoë*, Fig. 4, as imitating *Ithomia Flora*, Fig. 4A.

These resemblances are sufficiently striking when seen in the cabinet, or even as represented in the accurate plate which illustrates this article. But it is only when the animals are seen in the natural state that the palpable intentional imitation is seen in its full force; for those features of the portrait, says Mr. Bates, are most attended to by nature which produce the most effective deception when the insects are seen alive.

The next point to be considered is the useful end served by this mimetic analogy. In the majority of cases the motive is evident—it is protection against natural enemies, either by concealment or disguise. Those animals that resemble the objects with which they are surrounded are protected from the observation of others that prey upon them. The ground feeding birds, such as the partridge and snipe, the hare amidst the dried leaves, the ptarmigan in the snow, are all well known instances of the advantage of the assimilation of colour to that of surrounding objects. In the case of the South American butterflies the imitation is obviously for the purpose of disguise rather than of concealment. The Heliconidæ are a numerous and flourishing group: although slow flying, they are never persecuted by birds or dragon-flies, to which it might be supposed they would be an easy prey; nor when at rest on the leaves are they molested by lizards or predaceous flies, which constantly devour butterflies of other families. They appear to owe this immunity from persecution to their offensive odour, which renders them unpalatable to the enemies of insects. Even when set out to dry in the cabinet of the collector, they are less liable to be attacked by vermin than other specimens.

Now it is obvious that the more closely an inodorous butterfly of another species, resembles one of the bad-smelling and offensive Heliconidæ, the less likely will it be to be preyed upon by its natural enemies. Hence the imitation of the genera Ithomia and Methona by the persecuted insects of the genus Leptalis.

The mode in which this remarkable imitation is brought about has now to be considered. Some naturalists maintain that the resemblances existed from the Creation; but the difficulties in this view of the case are numerous. One of the strongest arises from the fact, that in those cases where a local

variation of the imitated animal exists, the imitator also varies to keep up the resemblance. Others say that as imitator and imitated both inhabit the same district, they are necessarily exposed to the same external conditions, producing the same amount of form and colour. This also is a perfectly untenable argument. It cannot be imagined that an insect resembles a green leaf or the bark of a tree, because both are exposed to the same physical conditions.

By the Darwinian Theory of Natural Selection, the explanation of these remarkable analogies is sufficiently easy. All animals, without exception, are liable to variation in form, colour, and in size. Among insects in particular, variations of marking and form are most frequent. Let us now imagine a race of insects, like those of the genus Leptalis, that have no special means of defence, and are consequently liable to be devoured by predaceous animals. When a variety of Leptalis arose which happened to resemble in any slight degree the offensive Heliconidæ, it would be much less liable to be pursued by predaceous animals than the unchanged original to which they were accustomed, hence that variety would have a greater chance of being propagated.

Similar variations would occur in subsequent generations, those imitations that most closely resemble the model always being left, until at last, as in the cases that we have illustrated, this remarkable result would follow, that two insects, belonging to distinct families, would so closely resemble one another as only to be distinguished by a close inspection of their structural peculiarities.

The use of the terms mimetic analogy and mimicry, as descriptive of these undeniable phenomena, has been strongly objected to by certain writers, who imagine that the words imply that the animals have power to change or alter their own condition. No supposition can be possibly more absurd. The change is not effected by the will of the individual animal, but occurs in the species; variations are involuntary, and at present even their very cause is unknown; all that is known is that they do occur both in wild and domestic animals, and that they are capable of hereditary transmission. And it is evident that those varieties that are protected in the most complete manner from their natural enemies, are the most likely to survive and perpetuate their race.

## AN INDIAN BUILDING INSECT (*PELOPŒUS MADRASPATANUS.*)

BY R. C. BEAVAN, LIEUT. BENGAL SURVEY.

In India, more so perhaps than in England, are to be seen, close to our very doors, an infinity of the wonderful productions of insects which, while they appear only curious to an ordinary observer, afford to a thoughtful mind proof of the great wisdom and regard displayed in the economy of even the smallest and, to us, apparently the most insignificant creatures.

There lies now before me the nest of a small species of Hymenopterous insect, which, by its size and solid appearance, would naturally lead one to suppose that the builder of it was considerably larger than it really is, and, as this structure of mud is commonly found in every verandah in this part of the country, and sometimes even in our rooms at this time of year, a few facts regarding the *modus operandi* of the architect may perhaps not be unacceptable to some of your readers. Before attempting a description, I would for a moment make a remark or two on the study of insect life in India. There are, I doubt not, numbers who take an interest in the subject, and would wish to pursue their investigations further, if they could but procure any work of reference which described our common insects, and, by means of figures, gave to the most uninitiated in the science of entomology the means of easily identifying an insect when captured. Such, I regret to say, is still a desideratum, and in order to find out any particular family or genus one has at present to wade through several English or French works on general entomology, too often with a very unsatisfactory result.

With the hope that others may be induced to assist in supplying this deficiency by recording their personal observations, I have ventured to send you this slight contribution towards a better acquaintance with some of the wonders around us, and must plead indulgence for the poor attempts of an amateur in this delightful branch of the study of Nature's works.

The insect I have alluded to belongs, as far as I can ascertain, to the family Fossores, of the Hymenoptera Aculeata. On examining it, the first peculiarity that strikes one is the very slender peduncle which connects the thorax with the abdomen, and it affords a matter for much wonder how such a mere thread can contain all the muscles, and connecting-tubes necessary to enable the insect to use his sting and perform the functions of life.

The nest it constructs is about three inches long, two deep,

and one and a quarter wide; while the insect itself, as may be seen by the figure, is considerably less than an inch in length. Only one insect does the work; in fact, the species appears to be solitary in its habits. The nest, when the cells are quite empty, weighs nearly two ounces, and is composed entirely of a hard mud, mixed up with little bits of gravel and grit, and cemented together by some secretion, until it becomes so hard that a knife can with difficulty cut it open.

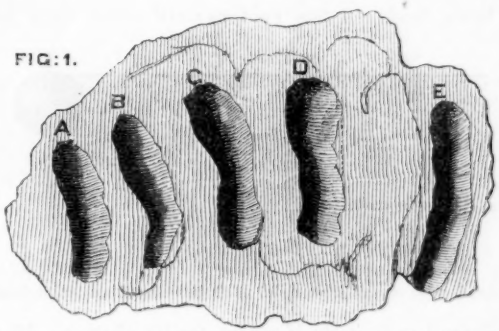


FIG. 1.—Smooth side of nest, which is fixed to beam or wall, showing sections of the first row of cells.

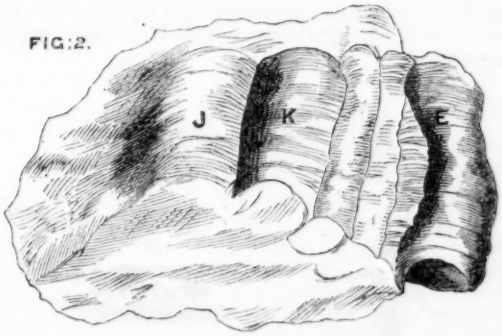


FIG. 2.—Outside view of nest.

Figs. 1, 2, 3, show the nest from different points of view. In the one I have before me for examination there was an unfinished cell E, which appeared to have been joined on to the structure after the nest was completed. As will be seen by Fig. 3, this nest consisted of ten cells, including E. From ten to twelve is the usual number, but I have occasionally seen

them with but five. The nest is generally built in the angle of two walls, or on a beam or rafter. After each cell is completed, the insect fills it up with spiders, some of them so large that it must require no little force to push them into it. They appear more stupified than dead—as if stung. Perhaps they are left in this semi-living state to keep them fresh for the consumption of the larva, which is hatched from the egg laid on the body of one of them. Were the spiders dead, the heat would soon shrivel them up.

The larva feeds on the spiders until either they have all

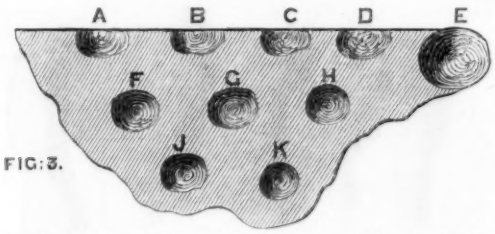


FIG. 3.—Section of nest showing all the cells. E cell not quite finished.

been devoured or it is itself ready for its change. The larva, I may here mention, is without feet. When about to change, it spins itself a kind of cocoon, for so I may term the interior cell (Fig. 4, A), which is composed of a transparent yellowish glass-like substance, sparingly covered on the outside with silky filaments.

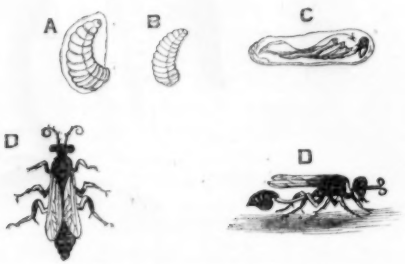


FIG. 4. A, Larva in interior covering. B, Ditto taken out. C, Pupa in advanced stage, in interior covering. D D, Perfect insect just emerged from cell.

The body of the grub (pupa) when taken out of this case (Fig. 4, B), is of a light yellowish colour, with its mouth and mandibles dark, which are hence easily distinguishable. It appears to grow gradually larger, and its shelly case with it,

until it gets more of the form of the perfect insect (Fig. 4, c), and, by the time it is full grown, the interior case has turned to a much darker colour, and completely fills up the interior of the earthen cell. The insect soon eats its way through both coverings, and emerges into air a perfect imago (D D, Fig. 4).

NOTE ON THE ABOVE COMMUNICATION.

The insect whose habits and nest are so well described in this communication, is the *Pelopœus Madraspatanus*, belonging to the Family Sphegidæ, Tribe Fossores. Another species, the *Pelopœus Bengalensis*, is also very common in some parts of Bengal. In the south of Europe, one species, *Pelopœus Spinifex*, is of frequent occurrence, but no example of this genus exists in Great Britain, the nearest representatives in this country being the Ammophilas, or Burrowing Sand Wasps, that store up caterpillars as well as spiders for the food of the larvæ. In the warmer parts of America the species of the genus Pelopœus are exceedingly numerous, and are popularly known as *Mud-daubers*. In many places they enter the rooms to affix their nests to the cornices, attaching them so firmly that the plaster is broken away if the nests are removed. In India, some of the insects belonging to different genera of the Family Sphegidæ are regarded with great favour, as they prey upon noxious animals, such as the disgusting Blattæ, or cockroaches. Many are distinguished by the great beauty of the colour of the body, and its high degree of brilliancy.

# THE DOMESTICATION OF ANIMALS IN THE MIDDLE AGES.

BY THOMAS WRIGHT, F.S.A.

At a recent meeting of the Ethnological Society of London, Mr. Francis Galton read an interesting paper on "The First Step towards the Domestication of Animals," in which he brought together a considerable mass of evidence to show, on the one hand, that many animals have a tendency to seek or accept the society of man; while, on the other hand, man, even in a low state of savage life, has a natural inclination to take animals to his bosom, and make pets of them. This is the result which appeared to me to be deduced from Mr. Galton's evidence, and I think that he had established it satisfactorily, and that he had very fairly explained the general causes for which one animal is found to be more easily domesticated than another. Perhaps, all animals are capable of being tamed to a certain degree, because mere instinct leads them all to be conciliatory towards those from whom they receive food, and they seem to have a natural readiness to place confidence in man when they are habituated to see him, and have no individual experience of having received injury from him. But it struck me that Mr. Galton had not sufficiently distinguished the two descriptions of taming, breeding in a domestic state and domesticating, and the two classes of animals which come under the general term, those which have been only known as tame animals and the companions of mankind through all historic ages, and those which are domesticated temporarily; and he seemed to assume that the present condition of the former class, the sheep and the ox, for instance, had arisen from original experiments in taming, made capriciously by savages, in the course of which those animals which only were fitted for permanent domesticity accepted their destiny and changed their condition. It would thus be the result of a sort of natural selection, a kind of Darwinian theory of the origin and progress of domestication. I confess that to me these two sorts of domestication seem to involve entirely different questions, neither of which do I propose to investigate here, for it is the latter class only with which I am concerned, and that only as it relates to one period, the middle ages of Western Europe.

There can be no doubt, I think, that man, and especially the tenderer sex, has a natural love for the taming of animals, and it is one of those feelings the universality of which we can understand without much difficulty. The fact that a wild

animal has been drawn from its ordinary state into familiar association with and dependence upon yourself, brings with it the consciousness of an influence extending beyond yourself, which is always pleasant; besides the desire felt by most people, and a strong one too, of possessing permanently what, untamed, they could only admire as it passed, for its beauty of form or colour, its harmony of voice, or the elegance and playfulness of its movements, or any other agreeable quality peculiar to it. And, also, there are other feelings mixed up with these which are not so easily defined, for there were periods in social history during which, under the influence of circumstances, the love of domesticated animals prevailed more strongly or extensively than at others. Thus, the saintly hermit, removed from the society of his fellow men, threw himself upon that of the brute creation, and cultivated their intimacy as at least an innocent recreation. Many of the legends of the early saints present us with anecdotes illustrative of this fact. At the beginning of the eighth century, St. Guthlac, in the solitude of Croyland, fed two ravens, which in their familiarity played him all sorts of mischievous tricks. "And," says the early writer of his life, "not only were the birds subject to him, but also the fishes and wild beasts of the wilderness all obeyed him, and he daily gave them food from his own hand, as suited their kind." One day a monk named Wilfrith paid a visit to Guthlac, and, "while they discussed in many discourses their spiritual life, there came suddenly two swallows flying in, and behold they raised up their song rejoicing; and, after that, they sat fearlessly on the shoulders of the holy man Guthlac, and then lifted up their song: and afterwards they sat on his bosom and on his arms and knees." A few years before this, St. Cuthbert tamed the rooks in his desert island of Farne, and made them familiar by the kindness with which he fed them and their offspring. A hermit of a later date on the same island, St. Bartholomew, tamed a small bird so that, for years, it came to perch on his table and eat from his hand. The first St. Bridgida similarly taught the birds in the neighbourhood of her hermitage to come to her at her call. Another Irish saint, Colman, tamed thirteen teal, which tended him on the small lake adjoining his monastic retreat. In the same way St. Columbanus, in his solitude in the wild country of the Vosges, tamed both birds and beasts, that they obeyed his voice and came to him at his call. Among them was a favourite squirrel, which, when he called it, came down from the trees, let him take it in his hand, and lay contented in his bosom. At a much later period, in the twelfth century, St. Godric, the hermit of Finchale, in Durham, tamed snakes and vipers, which in cold weather came and

warmed themselves at his fire. It would be easy to multiply examples like these from the early lives of the saints, which abound with them. The writers, forgetting the natural sympathy which seems to exist between mankind and the inferior animals, usually ascribed this familiarity between the hermits and the animals among which they lived to the miraculous influence of their sanctity; but there were other ecclesiastics, still more ascetic in their feelings, who thought otherwise, and, judging this sort of intimacy only another form of carnal sentiment, and calculated to draw away the mind from spiritual reflection, condemned it altogether. Among the injunctions in that curious *Ancren Riwla*, or regulations for the monastic life of nuns, they are forbidden to keep any, "except only a cat." St. Boniface, early in the eighth century, felt scandalized at the conduct of a German bishop whom he found playing with dogs and birds. And it is recorded of Robert de Betun, Bishop of Hereford from 1131 to 1148, on his own statement, that, besides a pet dog, he kept in his house a tame stag, a ram with four horns, cranes, and peacocks, and that in his last hours he repented of this as a crime, for in so doing he had not only let the "delights of worldly vanity" take possession of his mind, but he had wasted upon dumb animals the bread which might have contributed to the support of the poor.

A somewhat different cause led to a great fashion of keeping domesticated animals during the feudal period. Life in the feudal castle, closed up from the world around, which consisted chiefly of a population of servile or inferior rank, was extremely monotonous and dull; and, among the few classes of amusements which were available to enliven it, was that afforded by the possession of domesticated animals. Various allusions in early writers show us that there was hardly any castle, unless it were no more than a robber's stronghold, which was not supplied with a variety of domesticated animals; and many of them possessed also their little menageries of wild beasts remarkable for their rarity. We all know how many of our old ruins of castles contain some mysterious chamber which tradition points out as "the lion's den," and this tradition is not entirely without foundation. Kings and princes were no less curious in procuring such strange animals than the lesser nobles and gentry, and, of course, their castles contained larger collections. It will be remembered how much excitement was produced in England in the thirteenth century, when, in 1255, the French king, St. Louis, sent as a present to our King Henry III. a tame elephant. The latest remnant of this once prevalent custom was preserved in the old Menagerie in the Tower of London.

A curious work, recently published under the direction of the Master of the Rolls, furnishes us with some new and very remarkable illustrations of this practice. It is a treatise on Natural History, written in Latin by Alexander Neckam, a very distinguished English scholar of the latter half of the twelfth century,* who has enlivened his science by filling it with contemporary anecdotes and stories, many of them relating to the habits and characters of domestic animals, and especially to the custom of keeping them in the castles and great mansions, for the amusement of the household. We learn from these stories that the bear and the ape were common inmates of the castle; the former, of course, chained up, the latter at large. "It happened," Neckam tells us, "in the court of a certain wealthy man, which was stocked with a great variety of extraordinary beasts and birds," that there were a pair of apes and a bear, the bear chained to an iron stake. These animals afforded great entertainment to the inhabitants of the castle by their tricks. One day the female ape gave birth to a young one, and the mother was so vain of her offspring that she could not restrain herself from carrying it about, and protruding it upon everybody's attention. At length she presented it to the bear, which instantly grasped at and seized it, and tore it to pieces. The ape, overcome with grief, hurried to complain to her mate; and, after what appeared like a private consultation, the two apes gathered wood, and piled it under the bear, which appears, therefore, to have stood upon an elevated stand; and, as soon as they considered the quantity of the wood sufficient, they set fire to it and burnt their enemy to death. Neckam considers that the great peculiarity of the ape was its imitative power, which it sometimes practised to its own destruction, as in the following story, which, as he tells it, is further illustrative of the position of the ape in the mediæval castle. An ape resided among the battlements of a castle, and amused itself with watching a shoemaker at work in a cottage below, at a short distance from the walls. When other business obliged the shoemaker to leave his workshop, the ape would descend, enter the man's house by the window, and, taking the shoemaker's knife in his hand, would, in trying to imitate him, cut his leather to pieces, and cause him great damage and loss. There was not much chance in those days of a lowly artisan obtaining compensation in such a case from the lord of a castle, so the shoemaker resolved to seek at least revenge. One day, when the ape was in its usual place

* Alexandri Neckam *de Naturis Rerum libri duo*; with the Poem of the same author, *De Laudibus Divinæ Sapientiæ*, edited by Thomas Wright, Esq. Published by the authority of the Lords Commissioners of Her Majesty's Treasury, under the direction of the Master of the Rolls. Imperial 8vo. 1863.

watching from the battlements, the shoemaker took his knife, and drew the back or blunt edge of the blade several times across his throat, and then turned the other edge to it, and so on alternately, like a man sharpening his knife on a whetstone. He then left his shop, and made a longer absence than usual. The ape, which had been attentively watching the shoemaker's proceedings, immediately descended from the castle wall, and, entering his workshop, seized the knife, and, imitating the movements it had just witnessed, cut its own throat and died.

The ape was a common adjunct to the stock-in-trade of the wandering jougleur, or minstrel, who exhibited his tricks for gain. Alexander Neckam tells us one or two stories illustrative of this practice. There was an aged jougleur, who carried his ape with him from place to place on horseback, and gained his living by its many tricks, and especially by its dancing; but, having treated it on one occasion with unnecessary harshness, it took its revenge very craftily, and would have killed him had he not been unexpectedly rescued. Another jougleur had two apes, which, among other tricks, he taught to perform a tournament, which caused great amusement to those who witnessed it. Two dogs were taught to act as horses, and the apes, fully armed with shield, spear, sword, and spurs, urged forward their steeds, broke their lances, and fought with swords with all the earnestness of gallant knights.

There were two especially favourite birds in the castle and baronial mansion. The parrot was a much more common cage bird in the middle ages than we might be led to suppose. The parrot appears to have been known to the Anglo-Saxons under the name of *rago-finc*, the latter part of the word meaning simply a finch, but what the first part means I know not, unless it represents *hræge*, a goat, and why the parrot should be called a goat-finch is not clear. Alexander Neckam calls the parrot the jougleur, or minstrel, of the birds; not, be it remarked, on account of the beauty of its song, but because of its power of mimicry, and of its tricks and drollery. He speaks in another place of the mischievous cunning of this bird, and of its skill in imitating the human voice, and adds that it was more clever and amusing even than the jougleurs themselves. These qualities caused this bird to be looked upon with a certain amount of superstition, and it was thought that, in addition to the language of birds, by which they all understood one another, and which was the foundation of many mediæval fables and legends, the parrot understood the languages of man also. "There was," Neckam tells us, "a knight in Great Britain who possessed a parrot of high breeding, to which he was much attached." One day this knight was travelling in the East, in the neighbourhood of Mount

Gilboa in Samaria, which was believed to be the great country of parrots, when he saw one which closely resembled his own, on which he said to it, "Our parrot, which is shut up in a cage, and very like you, salutes you." To the knight's astonishment, the bird no sooner heard this than it dropped down as if dead, and our traveller pursued his journey. After his return to England he related this circumstance to his friends, in the hearing of his parrot in the cage, which immediately dropped down from its perch as if dying. The knight, believing this to be the case, took the parrot out of the cage and carried it into the open air, but he had no sooner laid it down than it rose suddenly and flew away, never to return.

The magpie, or, more properly speaking, the pie, was a favourite bird among all classes of the middle ages, and was tamed in the cottage as much as in the castle. The plot of more than one mediæval story is founded on the belief in the intelligence and cunning of this bird, and in its power of imitating the human voice. Several of these stories will be found in my *History of Domestic Manners and Sentiments in England*, to which the reader is referred. It appears from Alexander Neckam that a pie was usually kept in the poultry-yard (*chors*) of the mediæval mansion, because, from its watchfulness against depredators and the noise it made on their approach, it was considered a great safeguard for the poultry. The parrot also, in the house, was believed to be watchful in announcing the approach of thieves.

It would be difficult to limit absolutely the variety of animals which were domesticated in the middle ages. Birds were kept in cages from an early period, and, at all events after the Norman period, they seem to have been common. Among quadrupeds the Teutonic race had a great reverence, perhaps, we might say, a superstitious reverence for the character of the bear, and it was a favourite animal for taming from a very early period; partly, no doubt, because the bear is a docile animal, and may be taught many accomplishments which made it an absolute treasure to the jougleur. The gleeman, the Anglo-Saxon representative of the jougleur, and his dancing bear are represented in the illuminations of Anglo-Saxon manuscripts as far back as the tenth century, and appear frequently in those of a later date. In illuminations of manuscripts of the thirteenth and fourteenth centuries, of some of which copies will be found in *Strutt's Sports and Pastimes*, we have figures of the jougleur and his bear, in which the latter is sometimes standing on his head, and in others performs a variety of postures and antics. Sometimes the monkey is represented in the same character, and in one the monkey is riding upon the bear. These exhi-

bitions were so common and so popular, that among the regulations of the duties exacted at one of the gates in entering into Paris in the time of St. Louis, it was provided, that when a jougleur passed with an ape (and no doubt a bear came under the same regulation), he should be allowed to go duty free, on condition of causing the animal to dance before the toll-collector.

Among other animals which were tamed at an early period was the fox. In the life of St. Brigida, written at a rather remote period, we are told of a king in the north of Ireland who had a tame fox in his court, which frequently amused his guests by its cleverness and by the various tricks it played. At length, to the king's great vexation, some unlucky individual, taking it for a wild fox, killed it. The dog, though it is not a tamed animal, belongs in a manner to both classes of domesticity mentioned at the beginning of this paper, for, through all periods, no animal has been more petted. Some notes of the history of the dog as a lady's pet during the middle ages will be found in my *History of Domestic Manners and Sentiments*. An Anglo-Norman satire in verse, of the beginning of the fourteenth century, against the ladies who fed their pet dogs too delicately, is printed in the *Reliquiæ Antiquæ*.

The history of the domestic cat in the middle ages is a little obscure. The modern name is Teutonic. In English we preserve the word *cat* in its pure Anglo-Saxon form, and, as it seems to have been adopted into all the Romance tongues, instead of the Latin *felis*, as in French *chat*, in Italian *gatto*, in Spanish *gato*, etc., as well as in Welsh *gath*, we are perhaps justified in supposing that the mediæval use of the domestic cat was derived from the Teutonic peoples. It is curious, in connection with this view, that the cat is found rated at a much higher value in some places at a distance from the centre of Teutonic influence than in more purely Teutonic countries, such as England. The early Welsh laws fixed the price of a cat at three pennies, then equal to a considerable sum of modern money, and reckoned one cat for each village. By one of the laws of James I., King of Aragon, made in 1247, it was enacted that whoever stole a cat, and was convicted of the offence, should be considered as a robber (*latro*), and was therefore liable to capital punishment. It was perhaps the traditionary consciousness of the value of this animal in some countries which gave rise to the story of Whittington and his cat. That the domestic cat was common during the middle ages in England and France, and in other countries of the west, is evident from the numerous very early proverbs into which the name enters. Among these is one which may be traced as far back in England

as the twelfth century, and implies a certain degree of familiarity between the cat and its master. The earliest English form in which I have found the proverb is the following, taken from a manuscript of the thirteenth century:—

"Wel wot hure cat whas berd he likat."

*i.e.*, "Well knows our cat whose beard he licks." In the same manuscript the proverb is given in a Latin Leonine verse as follows:—

"Murilegus bene scit cujus barbam lingere suescit.

The line is given by Ducange in the following form, which appears to be of still greater antiquity:—

"Murilegus bene scit cujus genorbada lambit."

This strange word, *genorbadum* (for it is here in the plural), or *grenorbadum*, is only the French word *grenon*, or *guernon*, used so often in the early French metrical romances, and means simply the hair on the upper lip, or, as we now call it, the moustache. The same proverb is found in French, or perhaps I should say in Anglo-Norman, for it is, I believe, only met with in manuscripts of that language (probably written in England), in the thirteenth century. The Anglo-Norman poetess Marie quotes it in the following words in one of her fables:—

"Bien seit chat cui barbe il loiche."

*i.e.*, "Well knows the cat whose beard he licks." Its modern English form, for it has never become obsolete in our country, is, "The cat knows whose lips she licks."

I quote this proverb because its early popularity implies a considerable degree of familiarity between the cat and its master, not, it will be observed, its mistress. Joannes Diaconus, who wrote in the ninth century, in his life of Pope Gregory the Great, who flourished at the end of the sixth, says (c. lx.), speaking of his contempt for worldly possessions, that "he possessed nothing in the world but one cat (*præter unam cattam*), which, often caressing (*blandiens crebro*), he cherished in his bosom as a companion." I am not aware of any direct evidence to show that cats were made pets of at a later period of the middle ages. The cat, which was the only animal the nun was allowed to have in her convent, was evidently, like the one allowed to the Welsh village, intended for use, and not for amusement. In some of the droll sculptures of our old ecclesiastical buildings, as in the carvings of the stalls or misereres, we find cats figured as the pets and companions of weird-looking old women. One of the stalls in the church of Minster, in the Isle of Thanet, represents an old woman accom-

panied by two cats; but these subjects were evidently designed with a satirical aim.

There was another animal tamed in the middle ages, which, curiously enough, took partly the place of the cat; this was the weasel (*mustela*). This little animal was celebrated for its intelligence and cunning, the latter of which enabled it to overcome animals much bigger and stronger than itself. Alexander Neckam describes it as a great hunter and destroyer of rats, for which quality no doubt it was domesticated; and he adds that, in its domesticated state, it always carried its victims to lay them at the feet of its master or mistress. According to Neckam, it was a vengeful animal, and in the ignorance of those times it was believed to possess a deadly venom. This interesting writer tells the following story of a domesticated weasel. There was an old and poor woman who kept a weasel in her house, which had a litter of young. One day, while the mother weasel was absent, the old woman took the little weasels from their nest, and concealed them. When the old weasel returned, she searched in vain in every part of the house for her offspring, until at length, in her despair, she resolved on at least obtaining revenge, and finding a basin full of milk, she vomited her venom into it, intending that whoever drank of it should be poisoned. But the woman, who was only trying an experiment, and had watched all the weasel's movements, had, unobserved, replaced the young weasels in their nest. When the mother discovered them, she could not contain her joy, but she also wished to recall her vengeance, and she proceeded immediately to overturn the basin and spill the milk, so that nobody might drink of it. Another well-known writer of the same age, Giraldus Cambrensis, tells this same story, with slight variations, as having occurred in his time near Pembroke, in Wales; so that it was evidently a well-known popular story, and no doubt people believed it. But it presents a good illustration of the practice of employing the domestic weasel instead of the domestic cat.

The list of animals which were domesticated during the middle ages might be greatly enlarged, but the few notes here thrown together will probably be considered enough for a paper which must necessarily be limited. Squirrels ought to be mentioned amongst the favourite pets of the mediæval ladies, who are pictured in the illuminations of manuscripts as sometimes holding them by a cord fixed to a collar, while in some cases the squirrel is kept in a revolving cage, exactly like those in use at the present day. We read of an archbishop who kept a tame crane, which he had taught to bow its head and practise genuflexions when its master said grace at table, which gained for both a reputation for sanctity; whereas a secular nobleman

earned a reputation as evil as the one just mentioned was good, by keeping two tame ravens, which people persisted in believing to be a brace of demons who had only assumed the forms of those birds.

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## DR. BEALE'S PREPARATIONS FOR THE MICROSCOPE.

We have on former occasions expressed our admiration of the methods of research adopted by Dr. Lionel Beale, and we think he is fairly entitled to demand that those who controvert his statements of fact shall subject their opinions to the tests which he points out. Dr. Beale by no means affirms that the minute structures he has investigated can be seen *any how*. On the contrary, he declares that very careful preparation of a particular kind is essential to success. This is so much in accordance with the probabilities of the case that no one who declines to try this method of examination ought to be received as a valid witness in the matter; nor do we think any one who has only employed low powers, or high ones of inferior construction, can be placed in legitimate opposition to a singularly able microscopist, who has used the finest object-glasses that have been produced.

Few Continental observers seem to have any idea of the perfection to which our opticians have brought high powers. When the work of our best makers is employed, it is simply absurd to suppose that a high degree of enlargement necessarily throws doubt upon what is seen. Difficulties of interpretation are inseparable from many branches of investigation, but they are certainly not increased by a resort to first-class high powers, as anyone may satisfy himself by well-selected experiments. On the contrary, the high power continually gives certainty to what the lower power left as conjectural; and when it discloses appearances which lower powers did not indicate the existence of, the accuracy of the representation is as trustworthy as that of any other representation afforded with *the same amount of distinctness* by a lower power.

In Dr. Beale's researches into the distribution and termination of nerves, and into the formation of tissues, the plan followed has been to select an animal favourable for such inquiries, and to prepare it by injection and the subsequent free use of glycerine and solution of carmine. The green tree-frog (*Hyla arborea*) is his favourite subject. He kills the animal by wrapping it in a cloth and dashing it on the ground. An

opening is made in the sternum, the heart exposed, and a fine injecting-pipe, after being filled with a little injection, is tied on the artery. The injection is completed in twenty or thirty minutes, the fluid employed consisting of—

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|---|---|
| Price's glycerine . . . . . | 2 oz. by measure. |
| Tincture of sesquichloride of iron | 10 drops. |
| Ferrocyanide of potassium . . | 3 grains. |
| Strong hydrochloric acid . . . | 3 drops. |
| Water . . . . . | 1 ounce. |

Dr. Beale tells us that, when the injection is complete, the abdominal cavity is to be opened, and the viscera washed with strong glycerine. The mouth is slit on one side, and the pharynx washed in the same way. Any organ may then be dealt with separately, or the whole body, the legs having been removed, may be immersed in a carmine solution, of which the following formula is recommended:—

| | |
|---|---|
| Carmine . . . . . | 10 grains. |
| Strong liquor ammonia . . . . | ½ dram. |
| Price's glycerine . . . . . | 2 ounces. |
| Distilled water . . . . . | 2 ,, |
| Alcohol . . . . . | ½ ,, |

The carmine is first placed in a test-tube and shaken up with the ammonia, then boiled for a few seconds and allowed to cool. After an hour the other ingredients are added, and the solution filtered. Dr. Beale finds from four to six or eight hours, with occasional motion and gentle pressure, to be necessary to ensure the action of the fluid on every part. The blue colour imparted by the injection disappears when the carmine staining is complete. The frog is then removed from the carmine solution and well washed with common glycerine, after which strong Price's glycerine is poured over it, and in six or twelve hours this is poured off, and enough fresh glycerine (together with three or four drops of strong acetic acid) added to cover the preparation. In this state it is left for some days, and when it is ready for examination, a small piece of some vascular part will show, under the microscope, that the injected vessels are bright blue and the nuclei of the tissues bright red.

The particular portions to be examined are covered with glycerine on a slide, slightly pressed, and washed with glycerine containing five drops of acetic acid to the ounce. Processes of this kind are repeated after an interval of some days, and at last, by very gradual and gentle treatment, a portion is reduced to a condition in which the finest muscular or nerve

fibres can be seen. The greater the care and patience, and the more time expended on the preparation, the better it is likely to be.

Dr. Beale expresses a very high opinion of the use of glycerine in examining and proving a multitude of objects, the general principle of preparation being to take care that the glycerine is thoroughly absorbed.

Carmine and other dying materials will stain tissues and germinal matter likewise, but an alkaline solution of carmine passes freely through the former to the latter, and stains it so decidedly that the colour is not removed by glycerine washing.

We are convinced that Dr. Beale's researches will be the more highly appreciated the more completely and fairly they are tested; but an unscientific mode of reasoning sometimes tends to cast his substantial merits into the shade. In some passages he seems to take pains to stand as low as a reasoner as he is high as an observer, and he is singularly dogmatic where he is most likely to be wrong. When he tells us that vital power is not a manifestation of any known force, and that, though it is manifested under certain conditions, it does not result from those conditions, we want, in the first place, to know exactly what he means. Nor are we much helped when we are told that which is incorrect, namely, that "ordinary force seems for the most part to affect only the surface of masses," while "vital power acts from the very centre of the most minute particle." The most "ordinary force" we are acquainted with is gravitation, and it would much astonish Airey and Herschel to learn that it only "seems to affect the surface of masses." Heat and magnetism are also ordinary forces, and we fancy Faraday and Tyndall would scarcely agree with Dr. Beale that they only affect surfaces. When a force is said to act under certain conditions, but not to result from those conditions, the statement may be correct if made with suitable reservations. We believe it is so, for example, when mental and moral force—thought and emotion—are exerted by man under the conditions of physical mortal life; but we decline, in the absence of evidence to that effect, to regard every process of growth in the humblest living cell as resulting from a force totally distinct from all the chemical and physical conditions under which the growth proceeds. Dr. Beale asserts that no one has proved that, when living matter dies, any kind of force is set free. If no force were set free, we should have a unique instance of annihilation, and this Dr. Beale seems to imagine concerning a force that he regards as superior to all the physical forces which "change, but cannot die."

The assertion that "every structure consists of matter in two states—the living or germinal state, and the formed or lifeless state,"—which Dr. Beale repeats continually, is an instance of over hasty generalization. Can any one believe that as soon as an organ is formed it is dead, and that the only live matters in the world are those soft pulpy particles which are passing from an unorganized to an organized state? There are probably germs of valuable truth in Dr. Beale's speculations on this subject, but the "formed material" of his hypothesis is, we fear, as dead as his system could require.

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## THE JUNGERMANNIA SECTION OR GENUS OF LIVERWORTS, FRUITING IN THE WINTER MONTHS.

BY M. G. CAMPBELL.

It is marvellous that even in the present day, when microscopic research has ransacked hill and dale, dredged our ponds, and turned our garden slugs inside out for objects of interest and beauty, that so little seems to be known of a tribe of plants so eccentric in habit, and whose exceeding beauty and delicacy of structure pre-eminently fit them for subjects of microscopic investigation. It is true that Hooker wrote a work on the British Jungermannia some years ago, but how few know anything about the book; while more recent discovery has added to the list of our indigenous species several not named by Hooker.

Generally speaking, booksellers can give a tolerably correct idea of the measure of intelligence of a nation's mind upon any particular subject. Some little time ago, wishing to collect all the best works upon the subject, in any European language, we went from one scientific publisher to another, visiting many without meeting with one who seemed even to have heard the term before. It is true the term has no characteristic meaning in itself, being simply given to this genus in honour of a German botanist, Louis Jungermann; and it is to be regretted that compliments of this kind should, as they often do, stand in the way of the advancement of science.

A word descriptive of some peculiarity in the plant would be more attractive, contain information in itself, and be far more likely to fix itself in the memory, enlisting as it would the understanding in the effort to retain it. However, we must take things as we find them, and proceed to describe the

Jungermanniæ. Hooker places the genus between the *Marchantia* and the Lichens; Gottshe, Lindenberg, and Nees ab Esenbeck between Scapania and Sphagnæcetis.

With leafy developments of every imaginable variety of form, with usually extreme delicacy of texture and a perfection of cellular tissue, they have, with few exceptions, a terminal perichætium, perianthium, or *perianth*, as it is commonly called in this genus, of a tubular form; monophyllous; from the base, or only towards the apex, angularly folded, and splitting eventually into from three to six lacinated or toothed membranaceous portions, free or rarely united to the involucrum, except at the base. The perianth is sometimes double, seldom wanting, and the leaves of the involucrum, which surround its base, are for the most part distinct. The peduncle, or fruit-stalk, varies in length from a few lines to two inches or more, but is longer than the perianth, of an almost transparent substance, composed of oblong cells, and bearing on its summit the hard, firm capsule, which is, even to its base, quadrivalve, and when mature, being destitute of an operculum like the mosses, it splits its whole length to give exit to the young spores and elaters contained within; and once open, it has no power to close, but remains expanded, like a minute brown cross on the summit of the peduncle, till age or other cause dethrones it to commingle with the soil again. Before the splitting of the capsule, the elaters are doubly coiled or writhed like a rope rolled up in the interior; but they are very fugaceous, and no sooner does the capsule open, than they spring forward to bear the nursling sporules out to seek their fortune in the wide, dank earth.

The genus is monoicous, or rarely dioicous; the anthers are globose with short filaments. The stems are creeping or prostrate, either simple or branched.

The genus has numerous species; Lindenberg, in his *Synopsis Hepaticarum*, enumerates 137, chiefly European and American. For instance, 85 are indigenous to Europe and its islands; only 15 had then been discovered in tropical Asia, 9 in Southern Africa, 8 in New Holland and Australia, in tropical America 15, and 3 in North America, including Greenland. Besides which there are many species, which other authors assign to this genus, that are distributed by him among different genera of the Hepaticæ. They are terrestrial plants, or parasitic upon trees or among mosses; some of them showy, some slender and inconspicuous, chiefly perennial, perhaps none either annual or biennial. The texture of the leaves herbaceous, with large net-work, especially in the sub-tribe *Bicuspidatum*. But they are divided into two grand sections—the *Foliaceous*, which have distinct stems and leaves of delicate

consistence; and the *Frondose*, without distinct stems, and some of them with a fleshy foliage, more resembling that of *Marchantia*, or exceedingly diminutive and marvellously delicate *cacti*, but termed frondose from the perianth arising out of the leaf, thus constituting it a frond.

Many of the Foliaceæ have leafy expansions or stipules attendant on the true leaves, and like them greatly differing in the different species; hence arises minor subdivisions in their classification.

First, there are about forty *ex stipulatæ*, or whose stems bear no stipules: and these again are arranged in different groups.

1. *Jungermannia Hookeri*, *Hookerian Jungermannia*, has its leaves inserted on all sides of the stem. It is rare, and fruits in spring.

2. The next group contains about two dozen species which have *undivided leaves*, with a *bifarious* setting upon the stems. Of some of these the fruit is unknown, and the rest fruit chiefly in the spring; but of the third group, those having the leaves *emarginate* * and *segments equal*,

3. *Jungermannia ventricosa*, or the *tumid Jungermannia*, fruits in November. It is found in shady woods and banks, has a prostrate stem, somewhat branched, with patent subquadrate leaves, which are plane or inflexed at the anterior base, widely emarginato*-bidentatis, the teeth acute, the sides incurved, remaining unchanged in the dry state, the stem clothed with radicles or villæ among the leaves; fruit terminal, with an oblong inflated perianth, towards the apex contracted, plicate, and toothed. Many varieties of this species are enumerated in the *Synopsis Hepaticarum* of Lindenberg, differing in size, or in some minor particulars. Of these, variety *conferta* is densely matted, with more crowded leaves, more or less imbricated, slightly spreading, the anterior margin evidently inflexed, the perianth as well as the stem shorter, and the latter often giving off dorsal innovations.

Variety *gemmipara* bears very abundant gemmæ on the tips of the upper leaves, where they form little globes or balls, hence by some this variety is called *globulifera*. One variety, *minor*, is sometimes green, and sometimes of a purple colour.

Variety *laxa*, has a long lax stem, with leaves more or less distant, the inferior only patent, placed horizontally or spreading, and of soft texture. Other varieties are named as inhabitants of Europe, but we are not aware that they have as yet been found in the British isles.

*Jungermannia ventricosa*, as we have said, may be found in shady woods or on banks on the bare earth; it may also be

* Emarginate, having a sharp remarkable curvature passing inwards on the obtuse apex.

found on walls and on decaying trunks of trees, but never among mosses.

In the next group having leaves *triquadrifid*, and with *equal segments*, *Jungermannia pusilla*, or the *dwarf Jungermannia*, may also now be found in fruit. It has a nearly simple procumbent stem, short and stout, and its whole length clothed with long purple radicles on the under side, and having horizontal quadrate leaves, large in proportion to the plant, closely set, and irregularly waved, bifid, or trifid; the anthers are scattered naked upon the stem, the fruit terminal, with a campanulate perianth singularly large with a wide spreading mouth, waved and cut, an involucre of four or five subulate appendages, and a globose capsule, which instead of being firm, is of peculiarly thin and fragile texture, nurturing densely muricated spores, and, on their arriving at maturity, bursting, not into the usual cross, but irregularly. Another peculiarity of this singular little plant, a lover of moist shady banks, especially in a clayey soil, is, that sometimes two or even three capsules are thrown up from the same perianth.

In the same group with *Jung. pusilla* we have *Jungermannia incisa*, though the segments of its leaves are unequal, and here and there toothed. It is a minute species, frequenting wet bogs, with thickened creeping compressed radiculose stems, and crowded pale delicate green foliage, waved, complicated, or folded into itself, and cut, subquadrate in form, more or less spinuloso-dentate, the involucral leaves or bracts similarly shaped, but much more plicate and dentated. The perianth is short, ovate, plicate, and denticulated at the mouth. It fruits in winter and spring, but the fruit is rare, though the gemmæ are abundant, and, as in *Jungermannia ventricosa*, they collect into little balls on the tips of the leaves. Several varieties of this species are noticed by Nees ab Essenbeck, but as they appear to us chiefly, if not entirely, foreign, we think it unnecessary to point them out here.

The next group contains those whose leaves are bifid, with unequal segments, and conduplicate or longitudinally folded. These are chiefly spring fruiters, except *Jungermannia complanta*, or the *flat Jungermannia*, which bears fruit throughout the year. It has a creeping vaguely-branched stem, with distichous leaves, imbricated above, unequally two-lobed, the upper lobes larger and orbiculate, the lower ones ovate, appressed and plane. The perianth is oblong, compressed, truncate, or seeming to terminate in a straight cross line. Like *Jungermannia dilatata*, it is a parasite on the trunks of trees, to the bark of which it is closely pressed, but in pale green patches of an orbicular outline.

We now come to the sub-section Stipulatæ, comprehending

those whose leaves are attended by secondary leaves, or stipules. This section is also again subdivided into groups differing more or less from each other. The first contains those whose leaves are entire, or rarely emarginate. They all fruit either in spring or summer, and therefore we shall pass them over, and turn to the next group, which have bifid, or bi-trifid leaves with equal segments, and stipules much smaller than, and very distinct from the leaves, and as an example of the group we take *Jungermannia bidentata*, or the *triangular-sheathed Jungermannia*, which fruits both in winter and spring. It has an elongated sparingly branched procumbent tender stem, with ascending branches, ovato-triangular leaves, which are bifid at the apex, the sinus, or curvilinear indentation between the two projecting teeth, is semilunulate, or half-moon shaped, when seen under the microscope, the segment very acute and entire, the stipules much smaller, bifid, or bi-trifid and lacinated, perianth oblong, subtriangular, the mouth lacinato-dentate, and the involucral leaves deeply bifid. It thrives in humid shady situations, especially among mosses, and at the roots of trees. It is found throughout Europe, in North America, and in parts of Asia; and is an inhabitant of many islands, is of a pale whitish green colour, and has an agreeable and refreshing odour, which Hooker compares to that of the "dry earth, suddenly moistened by a shower." The illustration is not greatly magnified, but sufficiently so to exhibit the proportions, the fruit-stalk being long, and the perianth large in comparison to the rest of the plant.

Example of the Foliaceous section. J. bidentata, with fruit. The capsule burst, and the spores gone.

Another species, fruiting both in winter and spring, rarely found among rocks, but loving humid places and flourishing upon decaying wood and at the foot of alders, is *Jungermannia heterophylla*, or the *various-leaved Jungermannia;* it has a branched and creeping stem, with roundish ovate decurrent leaves, the apex generally obtusely emarginate or entire, rarely acutely delved out, the stipules bi-quadrifid, here and there lacinated, the perianth ovato-triangular with lacinated mouth.

In the next group we have those species whose leaves and stipules are nearly of equal size, and easily confounded. *Jungermannia setacea*, or the *bristly Jungermannia*, belonging to this group, fruits in October and November. It has a confervoid structure of foliage upon a creeping somewhat pinnately branched stem, the leaves and stipules similar, deeply bifid, or

bi-trifid, the segments short, setaceous, jointed like conferva; patent and incurved, the fruit terminal upon a short proper branch, the perianth oblong with an open ciliated mouth. It frequents moist and boggy ground in shady places, and also feeds upon the decaying stumps of trees. The foliage of this and that of *Jungermannia tricophylla*, or the *hairy Jungermannia*, which fruits in June, are so peculiar that they can never be confounded with any other British species, while the difference of their fruiting season sufficiently distinguish them from each other.

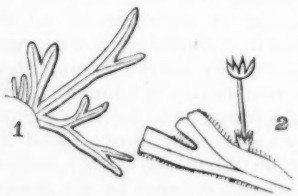
In the next group are included those which have *bifid leaves*, with *unequal conduplicate lobes;* and here another subdivision takes place—the first containing those whose lower or smaller segments are plane, and of these the fruit is either unknown or ripens in spring or summer. We therefore pass on to those species which have the *lower* or *smaller segments of the leaves involute*, and of these *Jungermannia Mackaii*, Mr. *Mackay's Jungermannia*, a very distinct and little known species, fruits during winter and spring. It has a creeping and irregularly branched stem, bearing leaves unequally two-lobed, the upper lobes rounded, the lower ones minute and involute, the large stipules are rounded obcordate, and the fructification is both lateral and terminal, the capsule globular, of delicate texture, and containing spiral filaments enclosed in transparent tubes; the perianth is obcordate, compressed, gibbous below, with a contracted mouth, which is also toothed. Though rare, this species occurs throughout the limestone districts in the south of Devon, climbing the trunks of trees, and hiding in the fissures of rocks. It has been found in rocks near Torquay, at Lowdore in Cumberland, at Killarney, Ballilicky, near Bantry, by river-side Aber, North Wales, and on Mount Edgecombe. We believe it was first found at Dargle by Mr. Mackay, whose name it bears.

*Jungermannia calyptrifolia*, or the *hooded-leaved Jungermannia*, also belongs to this group; ripens its fruit in October and November, and is not only among the most minute, but likewise amongst the most singular in structure of all the Jungermanniæ. Unlike the class in general, it grows in very small, scattered, detached tufts; its very short creeping stem, branched and wearing leaves, so remarkably attenuated at the point, and so like the calyptra of a moss, as to have originated its distinctive appellation. They are unequally two-lobed like the rest of the group, but the larger upper lobe is calyptriform, and the opening at the base is almost covered by the circumvolute lesser lobe, which is obtusely quadrate and incurved. The fruit is lateral, the perianth oblong depressed, with a contracted mouth sheltering the base of a short fruit-stalk, which

bears on its summit the transparent quadrifid capsule. Ireland seems to be the favourite country of this peculiar little plant, where it has a predilection for the stems of fir trees and of the dwarf furze, *Ulex nanus*. It has also been found at Lowdore by Mr. Wilson and by Sir Charles Lyell. Its colour is a yellowish-green.

Another parasite on the bark of trees, colouring their trunks with reddish-brown patches or blotches, and fruiting during the winter and spring, is *Jungermannia dilatata*, or the *dilated Jungermannia*, the most commonly met with of all the Jungermannia tribe, and also belonging to this group. It has a creeping irregularly branched stem, the upper lobes of its unequally bi-lobate leaves being roundish acute, the lower ones roundish saccate. The stipules are roundish, plane, and emarginate; the fruit is terminal with a triangular, obcordate tuberculated perianth. At a cursory examination this might be confounded with *Jungermannia Tamarisci*, the *Tamarish-leaved Jungermannia*, as indeed it often is; but their fruiting season is very different, Tamarisci ripening its capsules in July and August; it is also of a greener hue, and has a smooth, not tuberculated perianth, longer and more regularly pinnated stems, and is commonly met with on the ground, or creeping over low bushes.

And now we come to the Frondose division of the Jungermanniæ, which are less numerous than the *Foliaceous*, but, like them, parcelled out into separate groups, the first of which contains those which are destitute of nerves. These fruit in spring or summer. We shall, therefore, pass on to the next group, those *furnished with a nerve or costa*, and whose perianth is single. And here we have a slender, but very abundant species—*Jungermannia furcata*, the *forked Jungermannia*—which may be found on rocks, on heathy ground, about the roots of trees, or climbing their trunks, and sometimes on low bushes. It has a linear frond, as will be seen by the illustration, dichotomous, membranaceous, and costate, glabrous or smooth above, but beneath and on the margin more or less hairy, of a tender green hue, and the fronds so crowded together as to give it the appearance of a moss until it is closely examined, when its peculiar form sufficiently distinguishes it. The fruit arises from the midrib on the under side of the frond; the perianth is two-lobed, conduplicate, and has a ciliated margin. Several




Example of the Frondose Section of Jungermannia. J. furcata. 1, natural size; 2, a portion magnified, and bearing the capsule.

varieties of this species have been discovered, some with larger and some with smaller fronds. Variety *elongata* has a larger, more elongated, and straighter frond than ordinarily met with. This is the variety *maxima* of Weber, and is chiefly found on rocks in subalpine districts. Variety *æruginosa* has a broader frond of a blue-green colour, and, except in the gemmiferous plant, the extremities, or apices, are dilated and very obtuse. This is the *Jungermannia fruticulosa* of *English Botany*, and the *Riccia fruticulosa* of Dickson. It is found on trees in the West of England, Scotland, and Ireland.

The fructification of this and of *Jungermannia pubescens*, a nearly allied species, is, as Hooker remarks, very peculiar, anthers being found on the costa, on the under side of the frond, inclosed in and attached to a costate scale, rolled up like a ball; and gemmæ are met with on the *æruginose* variety, terminating narrow prolongations of the forking of the frond.

Thus we have endeavoured to give our readers some features characteristic of the winter fruiters belonging to this singular and anomalous tribe of plants, whose protean shapes and wondrous economy have been too long neglected, but which, we trust our intellectual readers will prove for themselves, can lend a fascination to many a winter walk, and whose microscopic investigation can afford a charm to many an hour of fireside enjoyment.

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## THE PARASITES OF THE COCKROACH.

BY E. RAY LANKESTER.

(*With a Tinted Plate.*)

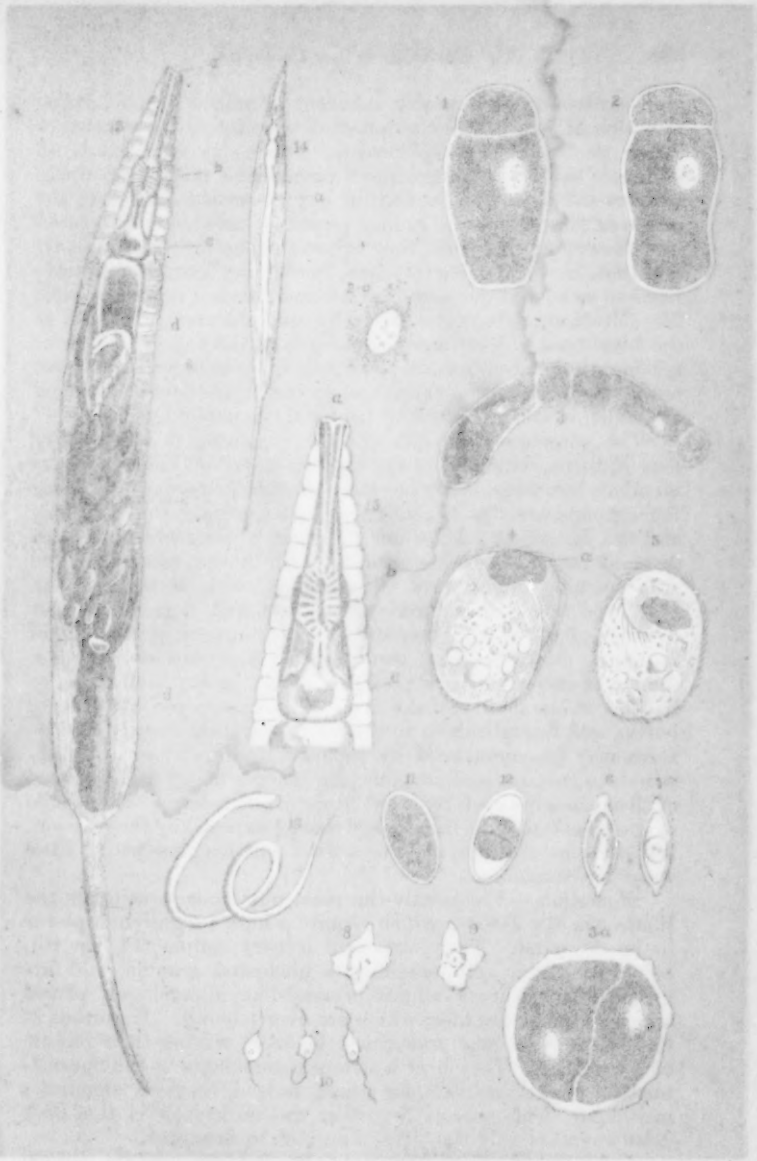
Of all classes of animals which come under the notice of the zoological observer, none are more attractive subjects for study, nor add more to the mysterious beauty of nature, than those which, by the peculiar modifications of their structure, are fitted to inhabit the intestines and viscera of other beings. What vast fields of speculation open out before us in considering their origin! Were they primarily created with the animals they inhabit, or have their original ancestors, infesting the food of their present host, been swallowed, and established themselves and their progeny as permanent visitors? The remarkable migrations to which some of the higher Entozoa are addicted, and the various forms which they assume, according to the animals which they happen to occupy, is one of the most remark-

able examples of the power, inherent in animal life, of transmutation of form under the influence of external circumstances which zoological science reveals. Such varied phases of existence as those to which the Tæniadæ are subject go far to support the view, independent of any general theory as to the origin of species, that all animal parasites have been introduced into the organisms which they inhabit at the first fortuitously, and that, in the course of time, succeeding generations have become more and more specialized and adapted for an entozoic life. Many animals are inhabited by several forms of Entozoa at the same time. Man himself is subject to the encroachments of not less than thirty species; and it is more than probable that not a single individual exists among the higher forms of animal life which is not inhabited by two or three parasitic species.

The common cockroach (*Blatta orientalis*) is infested by four Entozoa, which represent the four classes of animals whose members are occasionally or always internally parasitic. These four groups are the Monadina, the Gregarinida, the Infusoria, and the Scolecida. If, when the hour is somewhat late, you descend into the lower regions of your house, where the fire still burning illuminates the kitchen with a sullen, dim glow, you will find, as many know too well, a greater or less number of these flat, ungainly-looking insects scuffling and hastening over the floor; some in dense groups devouring a morsel of cheese or bread; others hiding under the fender, or basking in the liberty of the fire. Having secured a few in a bottle, and brought them to the microscope, the search for Entozoa may be commenced by separating the abdomen lengthwise into two unequal portions, the insects being first deprived of their consciousness by a few drops of chloroform. The whole of the intestine with the gizzard will be exposed by the incision, and portions of it may then be teazed out on a glass with a little water and examined.

*Monadina.*—Frequently the most numerous parasites in the Blatta are the Bodos, which require a high magnifying power to be observed. Their structure is very simple (Pl. fig. 10), being merely a cell containing a nucleated granule, and furnished with a pair of minute, thread-like appendages, placed opposite to one another, which are ever moving. Hundreds of these little cells may sometimes be seen, waving their minute cilia together. They bear a strong resemblance to the Spermatozoa of higher animals, for which, indeed, they are sometimes mistaken. The species found in the cockroach is the *Bodo Blattæ*, and is only the $\frac{1}{3000}$th of an inch in diameter.

*Gregarinida.*—In teazing out the intestine of the insect, little white translucent flakes may often be observed, which do not measure more than $\frac{1}{50}$th of an inch in length. When



E. R. Lankester, ad Nat. del.

PARASITES OF THE COCKROACH.

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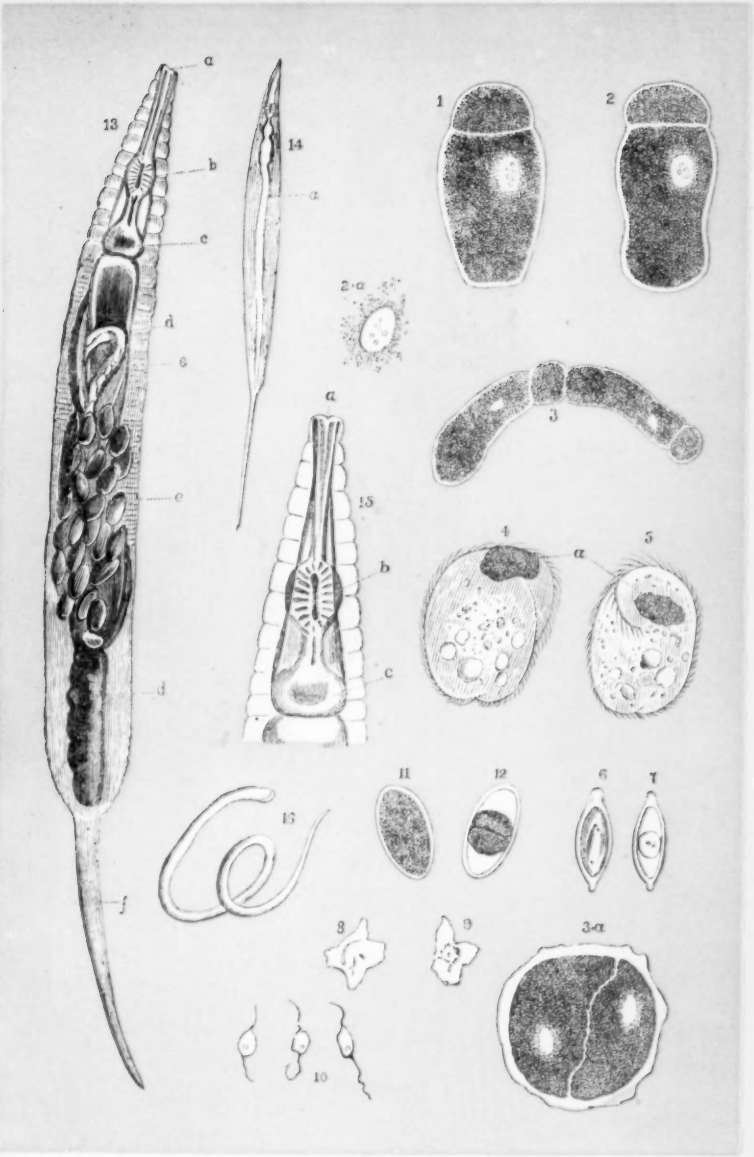
*Monadina.*—Frequently the most numerous parasites in the Blatta are the Bodos, which require a high magnifying power to be observed. Their structure is very simple (Pl. fig. 19), being merely a cell containing a nucleated granule, and furnished with a pair of minute, thread-like appendages, placed opposite to one another, which are ever moving. Hundreds of these little cells may sometimes be seen, waving their minute cilia together. They bear a strong resemblance to the Spermatozoa of higher animals, for which, indeed, they are sometimes mistaken. The species found in the cockroach is the *Bodo Blattæ*, and is only the $\frac{1}{1000}$th of an inch in diameter.

*Gregarinida.*—In teazing out the intestine of the insect, little white translucent flakes may often be observed, which do not measure more than $\frac{1}{20}$th of an inch in length. When

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PARASITES OF THE COCKROACH.

placed under the microscope, they have the appearance drawn in Figs 1, 2. These are the *Gregarina Blattæ*. The Gregarinida are a group of animals first discovered by Léon Dufour, the celebrated entomologist. They inhabit the alimentary canals of insects, Annelides and some Crustacea. In structure, though larger in size, they are nearly as simple as the Vibrio. A simple sac, which is very obscurely striated, and is highly elastic and moveable, encloses a mass of minute granules, in the centre of which is a clear, transparent vesicle; within the vesicle there are generally a few irregular granules, one of which is nucleated (Fig. 2*a*). In some species the sac is divided into two portions by a thin partition; one portion, which is much the larger, containing the vesicle and surrounding granules, whilst the other contains simply granules. This smaller portion is, however, sometimes provided with a proboscis, occasionally armed with little hooks, by which the Gregarina is attached to the walls of the intestine. The Gregarinidæ have thus been divided into two sections; the one single-celled and inhabiting Annelides and Crustacea, the other two-celled, and found in Insects and Myriapods. The single-celled division forms the genus Monocystis, a few species of which are large, and provided with a proboscis, while the greater number are minute and simple in form. The two-celled species form the genus Gregarina proper, and are more frequently provided with anterior prolongations of the membranous sac; though the species inhabiting the Blatta happens to be destitute of one.

The Gregarinida have no mouths, and live by absorption of the fluids of the animals they inhabit. Their movement is sluggish but constant, unless they are distended with granules, as is sometimes the case, or about to undergo the process of encystation. The process of encystation is the mode by which the Gregarinidæ are propagated. There appears to be no true sexual reproduction; but the following process takes its place:— Two Gregarinæ, or a single one, become quiescent, and are then invested with a structureless, transparent cyst or covering, which completely envelopes them (Fig. 3*a*). In the course of a short time, the two animals, if there are two, become confused into one dark, brown mass, which eventually splits up into little nucleated cells. These remaining inside the cyst, assume an elongated form, and at length emerge from their covering.

The changes which take place when the Gregarinidæ are encysted have been well observed in the *Monocystis Lumbrici*, which is very plentiful in the common earthworm. In parts of the reproductive organs of this Annelide hundreds of these Gregarinidæ may be seen in various stages of encystation; and it is from the observation of these that the entire amount of

our knowledge of the nature and manner of encystation is derived.

When the little cells escape from the cyst, they are of an elongated, doubly-conical form, in the earthworm bearing a strong resemblance to the Diatom *Navicula*—hence they have been called pseudo-Naviculæ (Figs. 6, 7). In the case of the *Gregarina Blattæ*, the cysts appear to escape from the body of the insect into the ground before the pseudo-Naviculæ emerge; but in the earthworm the little spindle-shaped cells may be seen floating about in great numbers. They, too, then pass out into the ground; and, when there, some are sure to be swallowed by an unsuspecting worm, or, in the case of *G. Blattæ*, by a greedy cockroach. The changes which they then undergo, after being retaken into the interior of their hosts, are not well known; but in the earthworm they seem to become flaccid and amœbiform (Figs. 8, 9), and then gradually develope into the perfect *Monocystis Lumbrici*. So much for the changes which the Gregarinidæ are subject to. The *Gregarina Blattæ* is rarely seen encysted, but has another curious habit which is sure to be observed. Two hang together, with the head of one to the tail of the other; that is, the smaller cell opposed to the larger cell, as in Fig. 3. The parasite varies in shape, sometimes being very much distended with its granular contents; at other times constricted in the middle, or looking like a representation of a stone preserve-bottle. (See Figs. 1, 2.) The *Gregarina Blattæ* may be preserved as a microscopic object, by mounting in a very shallow cell, in stiff jelly, to which an antiseptic has been added.

*Infusoria.*—Hastening about among the other contents of the stomach, and stopping only occasionally to swallow a minute piece of undigested matter, numerous individuals of a species of Infusoria may be seen. These animalcules have never yet been described in England, though they seem to be very plentiful in the intestine of the cockroach. They were, however, named by Dr. Leidy, of Philadelphia, some years since, who also found a species very similar to this one in one of the Myriapods, *Julus*. The writer has lately discovered two new species of this genus in other insects, which he hopes shortly to describe. The name of the genus which Dr. Leidy formed for these little parasites is *Nyctotherus;* the species which is found in the cockroach being the *N. ovalis*, whilst that of the centipede is *N. velox*.

Like all *true* Infusoria, they possess a mouth, but no anal aperture or alimentary canal. The animal consists simply of a transparent sac, longitudinally striated, and furnished with numerous cilia. The sac is filled with a clear, dense fluid matter, in which float particles of food, drawn into the mouth

(which is simply a slit in the tunic) by the action of long cilia which are placed around it. A dense granular area extends over a portion of the interior, and is the representative of the female generative organ. A smaller cell is sometimes developed on this larger mass, which contains the male generative particles. Spontaneous fission frequently takes place in these Infusoria; a portion of the nucleus and nucleolus, as the two bodies just described are called, separating with the rest of the animal. The *Nyctotherus ovalis* is oval in outline, and has the tunic slightly inflected at the posterior part, the mouth is very obvious, and the particles of food may be watched as they make their descent into the general cavity of the body. In movement it is very active, but seems to suffer considerably when placed in pure water, where it soon becomes quiescent, and eventually dies. It is evidently solely adapted for life in the thick and dense fluids of the alimentary canal of insects. The maximum transverse measurement of the Nyctotherus of the cockroach is the $\frac{1}{187}$th of an inch.

*Scolecida.*—Two species of parasites belonging to the class Scolecida occur in the body of the Blatta. One is the *Anguillula* or *Oxyuris macrura*, and is found in the interior of the intestine; the other is the *Gordius orientalis*, and occupies more rarely the general cavity of the abdomen. The Anguillula (Figs. 13, 14) is a minute, transparent little worm, about the $\frac{1}{8}$th of an inch long, or less. The walls of the body are annulated, most distinctly near the head, and are very elastic and transparent. The alimentary canal extends throughout the greater portion of the body, commencing in the first ring, where the mouth is situated, and terminates after passing along nearly three-fourths of the animal's length. The body becomes very much contracted at this point, and is produced into a thin, tail-like appendage. The peculiar-looking circular body marked *b*, is part of the œsophagus, and, together with the succeeding dilatation marked *c*, forms a very powerful and muscular apparatus. The intestinal tube which follows these is nearly straight (*d*), and has thickened walls, containing numerous brown granules, which secrete a fluid intended to assist in the process of digestion. The females, which, among the Nematodes, are larger and more numerous than the males, are generally found full of eggs, which are also seen floating about in the various early stages of development among the other contents of the intestine. The female generative organs (*e*) consist of a long cœcal tube, which winds around the intestine, and contains ova in various stages of development. An ovary, Fallopian tube, uterus, and vagina are distinguished by comparative anatomists. The ova in this species appear to float freely in the cavity of the body when they have attained a certain stage of

development; and individuals apparently dead may be seen crowded with eggs ready to issue from the opening which exists near the centre of the body. The male is provided with secreting organs, a receptacle, and "ductus ejaculatorius."

The fecundation of the ova takes place within the body of the female, and they undergo a certain amount of development in the intestine of the cockroach, but appear to be passed out of the insect's body and again swallowed before attaining maturity, although they do *not* undergo any larval stages, but are born with their parents' form and appearance.

No eyes or special organs of sense exist in the Nematodes, though the existence of an obscure nervous system has been ascertained. No circulatory or respiratory system has been discovered in Anguillula or any allied genera. The vinegar eels and paste-worms are non-entozoic members of the genus Anguillula, and live entirely independent of other organisms. With these exceptions, however, the Nematodes are almost all parasitic in the intestines of insects, Crustacea, and other animals.

The order Nematoidea is ranked, under the class Scolecida, with the Tapeworms (*Tæniada*), Flukes (*Trematoda*), and Hair-worms (*Gordiacea*), and some others. Of the last order named the parasite we now have to describe is a member. The *Gordius orientalis* is a whitish-looking worm, two inches or more in length, and is only occasionally found in the cockroach (Fig. 16). It inhabits the abdominal cavity. The mouth and intestinal canal are very difficult to trace in these animals, as they exist here only in a rudimentary state. To complete their development, the Gordii pass out of the insect they infect, and consummate their existence in moist earth or water. The Gordiaceæ infest nearly every species of insect, and sometimes are so numerous in certain spots, after leaving their "late proprietors," that stories of worm-rains, and similar fancies, have been originated. The Gordius of the Blatta is small compared to that which inhabits the violet-beetle (an insect scarcely an inch long), which measures sometimes no less than fifteen inches from head to tail, whilst other species are sometimes three feet in length. The *Gordius orientalis* is not so interesting a subject for study as the *Anguillula macrura*, on account of its immature condition; but a little searching in the damper parts of cellars and cupboards might bring some of the mature individuals to light, and the anatomy of this parasite could then be deciphered. In those Gordiaceæ which have been examined, the generative apparatus is much the same as that of the Nematoidea; but the males are somewhat different, the extremity of the body being bifid, and the reproductive outlet being placed here.

To any one with a good microscope, and some patience and

observation, the parasites of the cockroach cannot but form a most interesting study, as they not only present a great variety of beings of a peculiar and specialized organization, but also are very excellent initiatives to the study of the Entozoa generally, of which there is yet so much to be ascertained and discovered by the careful microscopic observer.

Explanation of Plate. — Figs. 1, 2. Gregarina Blattæ, *Siebold*. Fig. 2*a*. Vesicle, separated from the sac. Fig. 3. Two individuals attached. Fig. 3*a*. Encysted Gregarinæ. Figs. 6, 7. Pseudo-naviculæ of Earthworm. Figs. 8, 9. Young Gregarinæ of Earthworm. Fig. 10. Bodo Blattæ (Vibriones). Figs. 5, 6. Nyctotherus ovalis, *Leidy* : *a*, "nucleus." Figs. 11, 12. Ova of Anguillula macrura, *Siebold*. Fig. 13. Female of Anguillula macrura : *a*, mouth ; *b*, *c*, dilatations of muscular œsophagus ; *d*, intestine ; *e*, reproductive organs ; *f*, caudal extremity. Fig. 14. Young individual. Fig. 15. Head and muscular œsophagus ; letters as before. Fig. 16. Gordius orientalis, five times natural size.

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## CLUSTERS AND NEBULÆ.—DOUBLE STARS.—THE PLANET MARS.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

Before the constellation *Lyra* sinks too far towards the horizon we must take the opportunity of examining the most wonderful, though not the most conspicuous, of the many telescopic objects it contains. This will be

24. *The Annular Nebula in Lyra*, 57 M. Between *Wega* and *β Cygni*, but somewhat *s* of a line joining them, we notice two 3 mag. stars, not far asunder. These are *β* and *γ Lyræ*, *β* being the nearer of the two to its great sovereign *Wega*. Between them, about ⅓rd of the distance from *β* to *γ*, we shall detect, not probably with our finder, but by sweeping with a low power, a minute disc of feeble light, with a darkness in the centre, converting it into a ring. This singular object was discovered by Darquier at Toulouse in 1779, when a comet happened to be passing near it ; but neither he nor Messier and Mechain, the ancient observers of nebulæ, perceived the perforation, which was reserved for the eye of Herschel I. That feature might probably be seen, nevertheless, very fairly with 3 inches, or even a smaller aperture ; a power of 29 shews it *as a known object* with 5½ inches, but it rapidly gains in distinctness with increase of magnifying, which the whole nebula,

in striking contrast to the generality of these objects, bears remarkably well. I used to notice repeatedly with my former achromatic a frequent fluctuation of light, or twinkling, as it were, of the whole mass, much like the flickering of a gas illumination beneath a gentle breeze; and I still perceive it with my larger aperture. Its form is distinctly elliptical: Arago says as 83 to 100; Lassell gives 68″ × 89″ from actual measurement. Herschel I. considered it resolvable; his son found the edges not quite sharply defined, and discovered a nebulous light in the interior,* but did not perceive in its mottled aspect any sign of resolution. The Earl of Rosse, when he brought powers of 600, 800, and 1000 to bear upon it in his 3-foot reflector, found the internal light collected into wisps or stripes, and saw branching appendages at the outer margin, but he did not feel confident as to its resolvability; and eight subsequent observations with the 6-foot speculum, notwithstanding Humboldt's assertion to the contrary, still left the matter doubtful. Bond, with the great American telescope, recognized many stars in it. Secchi seems to have been still more successful with his clearly-defining achromatic in the Roman air; he says that in 1854 he resolved it entirely "en très petits points lumineux brillants comme une poussière d'argent très fine," observing at the same time that its light is feeblest at the ends of the longer axis; and this result has subsequently been confirmed by Chacornac in the use of the great Foucault silver-on-glass reflector of about 2½ feet in diameter. He resolves it into a mass of stars, of which the brightest lie at the extremities of the inner axis; the nebulous veil across the opening he also sees transformed into a thin layer of stars, and mentions a singular sensation of giddiness as the result of the twinkling of such a multitude of luminous points. There is nothing surprising in this; but it is matter of surprise indeed to learn that the investigations of Huggins, carried on by means of the spectroscope, lead to a most opposite conclusion. This observer, whose researches, in conjunction with Dr. Miller, into the constitution of the stars, are attracting so much and such deserved attention, found, in turning his instrument upon this nebula, that in common with several others of somewhat similar aspect, its light had a composition entirely unlike that of the stars, so far as they have been hitherto examined. It exhibited no trace of any of those metallic elements whose existence is so probable in them as well as in our sun; but, on the contrary, gave indications which, from their similarity to those of some terrestrial materials,

* This had, however, been previously noticed by Schröter and Von Hahn; the former also thought he saw changes in this nebula.

point to a gaseous constitution. In the spectra of several "planetary" nebulæ, as Herschel I. designated those of an unusually equable light and well-defined outline, three bright narrow transverse bands are found at some distance from each other, and of very dissimilar brightness—the strongest of which corresponds with the position of a band in the spectrum of nitrogen gas, the faintest with one in that of hydrogen, while the one intermediate in position and brightness marks some hitherto unverified element. In this annular nebula, owing, as it seems, to the feebleness of its light as compared with that of several objects of the same class, the possible line of nitrogen alone is distinct, and that of the unknown component merely suspected. "The bright line," Mr. Huggins states, "looks remarkable, since it consists of two bright dots corresponding to sections of the ring, and between these there was not darkness, but an excessively faint line joining them. This observation makes it probable that the faint nebulous matter occupying the central portion is similar in constitution to that of the ring."

This is an astounding announcement. The conclusions arrived at by two different modes of investigation seem utterly irreconcilable. It is difficult to question the result obtained by such a man as Secchi, and confirmed so fully by Chacornac. On the other hand, the admirably ingenious method of observation adopted by Huggins, and the delicate precision of the observation itself, are above all suspicion; and we seem to hang upon the horns of a strange dilemma. Either the determinations of spectrum analysis are perplexed by an experiment which exhibits solid materials under the guise which gaseous ones alone have hitherto been considered to assume, or else, in defiance of all analogy, the silver-dust of Secchi and the scintillating points of Chacornac must be held not to be stars, at least in the ordinary meaning of the word. Huggins, who, with due caution, doubts the identity of the bright band with that of nitrogen, on account of the absence of other lines of nitrogen, which are bright enough to be visible under the same circumstances, yet entertains no question as to the indications which have been presented to him. After enumerating eight planetary nebulæ which he has examined, including the one now before us, he says it is obvious that they "can no longer be regarded as aggregations of suns after the order to which our own sun and the fixed stars belong. We have in these objects to do no longer with a special modification only of our own type of suns, but find ourselves in the presence of objects possessing a distinct and peculiar plan of structure. In place of an incandescent solid or liquid body transmitting light of all refrangibilities through an atmosphere which inter-

cepts by absorption a certain number of them, such as our sun appears to be, we must probably regard these objects, or at least their photo-surfaces, as enormous masses of luminous gas or vapour; for it is alone from matter in the gaseous state that light consisting of certain definite refrangibilities only, as is the case with these nebulæ, is known to be emitted." And in allowing the possibility, he shows the great improbability of the existence of suns endowed with such conditions of luminosity, and of their being clustered into these systems. One thing, however, is evident. Our enterprising countrymen have entered upon inquiries whose interest it would be difficult to over-estimate. They may indeed lead to nothing beyond an increased conviction of the limitation of human knowledge, and the overpowering and inscrutable variety of the works of the Creator, but that conclusion alone will fully repay the trouble of their prosecution. The investigators have opened out for us a glorious vista, and however dim, or even unintelligible, may be the objects seen in that far perspective, the names of those who have revealed them will go down to posterity with honour.

That mysterious circlet, hung up, as it were, on high at once to challenge and perplex our inquiries—whether it may be a flat ring of suns, circular perhaps in reality, but presented somewhat obliquely to our sight; or a starry cylinder or funnel seen endways, according to Chacornac's comparison; or a huge perforated mass of luminous vapour—will henceforth be among the most fascinating subjects of investigation for instruments and apparatus of the highest class. It would be matter of exceeding interest, too, if we could attain to even the most vague idea of its distance and dimensions. Of these, however, we know at present even less than of its constitution. There is not the slightest indication to guide our conjectures. It may be a body of stupendous magnitude at a corresponding remoteness; or it may occupy a comparatively near position, if anything can be called near in the vast expanse of the starry heavens. Measures of parallax, which alone could solve the question, have not as yet been undertaken, and they would no doubt be difficult and uncertain from the want of a sharper outline, though this might possibly be compensated in some degree by an average taken from its four edges. The neighbourhood is not barren in stars, some of which might serve as standards of comparison; and there is one little star very near it, which, if sufficiently bright, might possibly be used as a point of departure. Herschel II., who gives its position measured from the centre of the nebula 96°·4, and its distance from the edge rather more than the breadth of the ring, assigns to it 11 mag. To me it now appears smaller. At

least I do not recollect having remarked it with my $5\frac{1}{2}$-inch achromatic, though it is sufficiently visible when looked for, till it forced itself upon my notice with an 8-inch silver-on-glass speculum, which exhibited the nebula in great beauty, and seemed to show faintly the wisp-like appendages at its outer edge.

This nebula, from its superior brilliancy and distinctness, may be taken as the representative of its class, of which but few are known to exist. The Earl of Rosse had only been able to identify seven in 1850. If future investigations should ever demonstrate their stellar composition, they would have a most important addition to their number in the starry ring which surrounds, though a little excentrically, our own system. The Galaxy would then be held the chief of the annular nebulæ. The analogy, however, would not be a close one, and there would be a great difference, if not in kind, yet in degree. The Galaxy, though undoubtedly it would appear as an annular nebula if viewed from a distant point lying far out of its plane, would evidently be extremely faint in proportion to its diameter, and could scarcely be a recognizable object if removed so far as to subtend an angle of only one or two minutes. If the nebula in Lyra is an aggregation of stars, they must be much larger, or more brilliant, in proportion to the whole dimensions of the annulus, than the extremely minute points of the Milky Way.

In the *Catalogue of Nebulæ*, published by Sir J. Herschel in 1833, this object stands No. 2023. In the more extensive *General Catalogue*, which we recently owe to the same great observer, and of which more hereafter, it is numbered 4447.

By way of contrast with this marvellous ring, we may try to find

25. *The Second Nebula in Lyra.* 56 M. To get hold of this, we must revert to our old acquaintances *γ Lyræ* and *β Cygni*. In mid-distance between these, or somewhat nearer to the latter, and a trifle perhaps above the line, we must sweep with our lowest power, as a common finder will hardly have light enough, till we come upon a faint cloud, whose hazy aspect is so curiously dissimilar to the sharp clear outline of its annular neighbour, that on that account it deserves a little trouble in the search; and it must strike us as singular that, whilst the nature of the other is still equivocal, this feebler object readily reveals its composition. Smyth calls it a globular cluster. Herschel II., in his catalogue of 1833 (where it is No. 2036), calls it a "fine compressed cluster; round, inclining to a triangular form; brightest in the middle; stars 12 ... 14 mag. A fine object, diameter 3′." I found it "faintish, but probably resolvable," with $3\frac{7}{10}$ inches; with 29 of $5\frac{1}{2}$ inches it

was a rather dull hazy circular mass, clearly resolvable with higher powers, and elongated N. and S., but not bearing magnifying like 57 M. It lies in a beautiful field, all sprinkled with minute stars, a small star lying closely *p*. It is No. 4485 of H.'s *General Catalogue*.

In a very different quarter of the sky beautiful objects are awaiting us, which we had better secure before they reach an uncomfortable elevation. The order of the Greek letters in *Ursa Major* being that of the principal stars, we draw a diagonal line through the quadrilateral from $\gamma$, the 3rd star, to $a$, the most northerly of the *Pointers*, and carry it on as far again, till its end falls in a barren-looking space. Here we must sweep about with our finder, in default of a serviceable guide, till we come across two little feeble white clouds in the same field; or, if our aperture is small, one only may be readily distinguishable. These will be the *Two Nebulæ in the Ear of Ursa Major*, 81 and 82 M. We begin with the brighter, which is also the more southerly, the two lying nearly in the same meridian, about half a degree apart, so as both to come into a very low-power field.

26. 81 M. (*Ursæ Majoris.*) This is a beautiful bright nebula, of a lengthened oval form, much condensed towards the centre, where its light assumes a more circular arrangement, and is very intense, its general aspect bearing some resemblance to the great nebula in *Andromeda* in miniature. It was discovered by Messier in 1781. Sir J. Herschel, in whose catalogue of 1833 it is by mistake printed M. 82 (No. 649), speaks of it as "gradually brighter, and then suddenly very much brighter in the middle," the most condensed part being $4' \times 3'$; but its faint rays extending nearly 15'. The position of the axis he gives = 156°. Two small stars will be seen projected upon the nebulosity: a little *s p* lies a considerable star, which close examination will prove to be double; a more obvious, though smaller pair lies between it and the nebula; and the configuration and contrast of the whole group is singularly beautiful.

27. 82 M. is a long narrow beam, a little curved, and thinner at each end. It is very bright for a nebula, though inferior to its more conspicuous neighbour. Smyth thought it especially luminous on the N. side; but this I was unable to confirm, and even had a contrary suspicion; the *f* portion also seemed to me a trifle the brightest. It is prettily grouped with surrounding stars. Herschel II. describes it in his *General Catalogue* as "very bright, very large, very much extended; a beautiful ray."

These two nebulæ are said to have exhibited a mottled appearance to ♅, but I have met with no account of their aspect in

the gigantic instruments of modern times, nor does the *General Catalogue* refer to them as resolvable. The strength of their light might have been thought an indication of nearness, and consequent resolvability, had we not already learned the inadequacy of any such test; and it is not unlikely that the following assertion of Sir J. Herschel may find its application here:—"There is one circumstance which deserves especial remark, and which, now that my own observation has extended to the nebulæ of both hemispheres, I feel able to announce with confidence as a general law, viz., that the character of easy resolvability into separate and distinct stars is almost entirely confined to nebulæ deviating but little from the spherical form; while, on the other hand, very elliptic nebulæ, even large and bright ones, offer much greater difficulty in this respect. The cause of this difference must, of course, be conjectural, but, I believe it is not possible for any one to review *seriatim* the nebulous contents of the heavens without being satisfied of its reality as a physical character. Possibly the limits of the conditions of dynamical stability in a spherical cluster may be compatible with less numerous and comparatively larger individual constituents than in an elliptic one." When these most interesting remarks were penned, in 1845, the great reflector of the Earl of Rosse had just been brought into action, and its extraordinary disclosures had led the illustrious writer to incline to the idea that all nebulous matter might be ultimately proved, or at least fairly inferred, to be of a starry nature. No material advance, however, has since been made in this direction, and the question is by no means set at rest. Even if it had been previously considered as settled, it would have been reopened by the discoveries of Huggins. If the not improbable assumption may be admitted, that these two nebulæ are at about an equal distance from the earth, they must be comparatively near one another; each must form a magnificent object in the other's firmament; and if they are really of a starry nature their component suns must shine with distinct and impressive splendour. 81 M. especially, even if no more of its extent were perceptible there than here—a most unlikely supposition—would occupy perhaps a space equal to the breadth of ten full moons with its denser brightness—possibly twice as much with its outlying rays. 81 M. is No. 1949, its neighbour 1950 of the *General Catalogue*.

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Reference having been repeatedly made to the new Catalogue of Nebulæ and Clusters of Stars, by Sir J. Herschel, a short description of it may not be unwelcome here. This admirable production, the result of most accurate and unwearied research both in the heavens and among the labours of other

observers, far surpasses in completeness everything that has hitherto appeared, and will hereafter be universally referred to as the standard authority upon the subject. It was presented to the Royal Society, October 16, 1863, and has been printed in their Transactions for the present year. It combines all the previous catalogues and descriptions of Messier, Mechain, La Caille, Herschel I., Dunlop, Secchi, Bond, Mason, D'Arrest, Auwers, Lassell, and the Earl of Rosse, and contains 5079 objects, of which, however, some few may have been comets or mistaken entries. They are arranged in order of Right Ascension, which, as well as North Polar Distance (more convenient for such a purpose than Declination in European latitudes, as reckoned all one way) is computed for 1860, with columns for Precession to 1880. The corresponding synonyms are all given, and references to other authorities: the number of observations specified, and a summary description added of each nebula or cluster, from a comparison of all previous observations and remarks. The place of every object has been independently calculated both by Sir J. Herschel and Mr. Kerschner, one of the occasional computists at Greenwich, specially employed by the Astronomer Royal for the purpose; —a truly laborious task, comprising between nine and ten thousand entries separately computed by each party. The value of this noble contribution to science will not be estimated by the remark, however true in itself, which the author makes with characteristic modesty, when he says that "for the want of such a general catalogue . . . a great many nebulæ have been, from time to time, in the *Astronomische Nachrichten* and elsewhere, introduced to the world as new discoveries, which have since been identified with nebulæ already described and well-known. Many a supposed comet, too, would have been recognized at once as a nebula, had such a general catalogue been at hand, and much valuable time thus saved to their observers in looking out for them again."

A mass of valuable notes is prefixed to the catalogue, from which some extracts of especial interest will be laid before our readers in a future number.

## DOUBLE STARS.

Our search among the nebulæ has brought before us two interesting pairs, which have been already mentioned as lying *s p* from our No. 26 (81 M.). The nearer, smaller, and more open of these is

125. 1387 Σ, who calls it 8″·93. 269°·6. Equal, 9·5 mag. of his scale, équivalent to about 10 of Smyth's (1832·97).

The more distant and brighter is

126. 1386 Σ, according to him 1″·983. 296°. Nearly equal, 8·2 mag. of his scale (1832·11). 9 mag according to Smyth.

Mr. Knott has obliged me by remeasuring these objects with his beautiful 7½-inch object-glass, by Alvan Clark. The former appears unchanged in distance, and nearly if not quite so in position; to the latter, the very aspect of which shows that it must have been closing up since Struve I.'s time, he gives a distance of 1″·596 (1864·04), a result corroborated by Dembowski's estimate of 1″·5. The probability therefore is that this beautiful pair is in orbital motion, in a plane passing nearly through our eye, as is shown by the absolute fixity of angle during thirty-two years. A power of 111 sufficed to divide it with my 5½-inch aperture. The contrasted aspect of these adjacent pairs, and their utter dissimilarity in character from the great hazy mass of light beside them, render this a truly remarkable field.

## THE PLANET MARS.

Advantage should be taken of the present position of this interesting planet, now just past his opposition (Nov. 30), to corroborate and complete the observations of 1862. He is unfortunately at a greater distance from the earth, and his largest diameter is consequently only 16″·6, instead of 21 ·8, as on that occasion. As however he will be still less favourably circumstanced in future oppositions for some time, the present opportunity should be made as much use of as possible.

## OCCULTATIONS.

December 4th. $c^1$ Capricorni, 6 mag., from 9h. 4m. to 9h. 34m.—5th. $\kappa$ Aquarii, 5 mag., from 8h. 35m. to 9h. 29m.—16th. $A^2$ Cancri, 6 mag., from 9h. 41m. to 10h. 46m.

## THE DECAY OF WOOD CARVINGS.

THE Committee of Council for Education, laudably anxious to preserve the excellent specimens of wood carving in the collection at South Kensington, appointed a Commission to report upon the cause of the decay of such objects, and to suggest the best means of prevention and restoration. That report has just been published, and contains matter which will interest every possessor of ornamental wood-work.

Professor Westwood stated to the Commission that the insects most destructive to wood furniture belonged to three species of beetles, of the family *Ptinidæ*, and known under the names of *Ptilinus pectinicornis*, *Anobium striatum*, and *Anobium tessellatum*. "The first of them," says the Professor, "is about one-fourth of an inch in length, and the male is distinguished by its beautiful branched antennæ; the second, which is by far the commonest and most destructive, is about one-eighth of an inch long, and of a brown colour, with rows of small dots down the back; and the third is about one-third to one-fourth of an inch long, the back varied with lighter and darker shades of brown scales." The females deposit their eggs in crevices of wood-work, and the grubs, which exceed the insects in destructiveness, are small and fleshy creatures, resembling the grubs of the cockchafer in miniature. These grubs burrow in the direction of the fibre, if the wood be new; but when old and dry, they proceed in all directions. The perfect insects come forth in the first hot days of summer; and this fact should prompt those whom they injure to look for them and destroy them at the right time. So rapid are the destructive powers possessed by these creatures, that Professor Westwood adduces the case of a new bedstead which was completely reduced to powder in three years.

They do not like wood saturated with creasote, solution of quassia, or corrosive sublimate; but it is not always possible to subject the materials of which ornamental articles is composed to those processes.

In dealing with specimens that had been assailed, the Commissioners found that some insects could not survive prolonged exposure to the vapour of benzine or chloroform. They placed small articles in a glass case containing small saucers, holding bits of sponge, saturated with these fluids. Carbolic acid (or creasote) did not destroy the insects when used in the same manner.

A solution of corrosive sublimate in methylated spirit, was found by the Commission to give an appearance of varnish not always desirable. Mr. Peter Graham exhibited specimens that

had been coated with thin clear parchment size, which, being an animal substance, was supposed to be unpleasant to the wood-eating insects. This did not affect the appearance of the carving, and the Commission recommend the adoption of this treatment as a preventive, adding about sixty grains of corrosive sublimate to one pint of size.

The report describes a successful process of restoration adopted by Mr. G. W. Rogers, in the case of the fine carvings by Grinley Gibbons, belonging to Belton House. Mr. Rogers had photographs taken, so that the exact position of the various parts of the carving might be known. He then employed corrosive sublimate in its aqueous solution; and to restore the colour which was injured by its use, he resorted to ammonia, and in some cases to a "slight treatment with muriatic acid." "After this, the interior of the wood was injected with vegetable gum and gelatine, in order to fill up the worm holes and strengthen the fabric of the carvings." Finally, a varnish of resin and spirits of wine was applied, and the dismembered pieces put together in conformity with the photographs.

When the objects could be removed, and were not too large, we should have thought it advisable to have placed them in a vessel, from which the air could have been exhausted. They would then, on the introduction of the benzine or chloroform, and probably also of the carbolic acid, thoroughly absorb the vapours. The latter substance might act under such circumstances to an extent sufficient to kill any insects that could stand the partial deprivation of air, and to destroy the eggs. In the case of chloroform we apprehend no permanent effect would be produced on the wood, and benzine would probably be equally evanescent in action. The carbolic acid would, on the contrary, if once effectually introduced, be likely to render the substance distasteful to the insects for many a long year.

# ON THE INFLUENCE OF WATER AND ICE IN FORMING THE PHYSICAL FEATURES OF THE EARTH.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

It is an opinion that was once so common as to have been almost universal, and that is still expressed *ex cathedrâ*, without the slightest hesitation, by geologists of the old school, that fractures, violent and sudden upheavals, and other convulsive movements of the earth's crust, have originated all the marked and prominent features of the surface of our globe. The reader, if he has derived his knowledge of geology from some of the many popular elementary books on the science, will probably believe that this doctrine is one of the most elementary and unquestioned in the science. He will have an impression that water, although powerful as a depositing, is comparatively unimportant as a formative, modifying, excavating, and destroying agent. Such was to a great extent the geological faith of a quarter of a century ago, and therefore in all works in which the knowledge of the author is derived second-hand from books, it is likely that such principles will prevail. There is, however, a modern school of geology, in which water is recognized as a first-class power in nature. Whether in its fluid or solid state, water is believed to have been a *primum mobile* in all places and under all circumstances in which it can act. But most of all is the influence of water now recognized as a mechanical agent, when it becomes necessary to account for the grandest of all phenomena, the configuration of a great mountain chain. The giant needles of granite shooting upwards through the clouds, the sharp serrated ridges of naked and hard rock, the deep gorges, often systematic, and either seeming to radiate from a centre or run parallel to each other for a long distance, the absence of such soft stratified rock as we see forming the lower hills and the plains, the general wildness and ruggedness, and the apparent permanence of the phenomena, the scenery remaining unaltered as we think from century to century;—all these combine to suggest some great convulsion of nature as concerned in the work before us, and some cause which, having effected a change, ceases to act, and leaves the face of nature undisturbed. And when we examine the deep chasms connected with certain valleys, and see the contortions of the rocks which apparently correspond on opposite sides of these valleys; when we recognize details which render it certain that enormous upheaving and squeezing forces have been concerned, we are yet more

inclined to take for granted the further assumptions of those who adopt the fracture theory. It is easy to believe, with these facts before us, that all valleys that are deep and strongly marked are valleys of elevation or fault valleys, and that lakes occupy the depressions caused by the slipping down and falling in of strata, or the removal of rocks broken during the convulsive throes of a great upheaval. We see in imagination a fearful disruption and a rending of the solid crust of the earth; wide and deep fissures are produced, granite is thrust up through the softer and more yielding shales, clays, sands, and limestones; the whole form of the mountain chain and all its details are determined by the first elevation, and the continued thrusts upwards in the same direction are all subordinate. Each thrust upwards is an epoch, and rest must follow each effort. At length there results a chain like the Alps, presenting every variety of form; and the chain, once formed, must, we imagine, remain quite unaltered for ages.

It is a good many years since Agassiz, followed by some other bold speculators in geology, ventured to suggest that the glaciers that now lazily creep down certain mountain valleys of Switzerland are but the puny remains of other glaciers that once crossed the whole of the fertile valley of Switzerland from the Alps to the Jura, and that covered much land elsewhere in Europe and North America. He insisted that there was a period—not very long ago, speaking geologically—when huge rivers of ice covered the land, when great icebergs drifted through the sea that surrounds our shores, and when all the surface gravel that abounds in the northern hemisphere was being formed and deposited and transported by ice and water. This startling hypothesis, as it once seemed, is already a part of the alphabet of geology. We speak of the glacial period with as much certainty as if its history had come down by human tradition. No one hesitates to admit that the striations and scratches in rocks, under and near gravel, are the results of the passage of ice; and the whole subject of the influence of ice is admitted as far as gravel is concerned.

Much more recently views have been put forward which may seem quite as startling as those connected with glaciers did to the geologists of a former day when they were first presented. These views are opposed vehemently, and even bitterly, by some of our very eminent geologists, and even by some of those who fully admit that glaciers have transported huge blocks of crystalline rock across Switzerland. But they are views that have already received very powerful advocacy, and they are daily acquiring fresh importance.

The more carefully and minutely the evidence has been investigated, the more clearly has it appeared that glaciers are

agents of the greatest importance in modifying the physical features of the countries in which they exist on a large scale. The Himalayan mountains and the mountains of New Zealand have been found to exhibit these phenomena on a grand scale. In the former one glacier alone has a length of 36 miles, more than three times that of any existing Alpine glacier; but in the Alps themselves, on the Italian side, there is proof of the former existence of ice streams, one of them 50 miles in length, and others even more. The hills throughout the valley of the Po are mere remains of old moraines left behind by the glaciers of the south side of the Alps.

But glaciers combine in some measure the properties of solids and fluids. They are solid and hard, and exceedingly heavy; and being loaded frequently with hard rocks and stones throughout their mass, they grind powerfully the rocks over and between which they pass. Being in a state in which the parts move on each other, they flow in a certain sense, adapting themselves to all the inequalities of the channel through which they pass, and in this respect moving like thick tenacious fluids, such as treacle. They can certainly exert an eroding and excavating and polishing force on the rocks they cross, and this to an enormous extent; so that the water coming from them is loaded with mud, and their surface is covered with stones and rocks that they have in their progress torn away or ploughed up.

Now, the view of the younger school of geologists is that the whole present configuration of mountain chains, the valleys and even the rock-basins now filled with fresh water and forming lakes, as well as the outline of the hills and plains over the whole continent of Europe, Asia, and North America, are really due not to any rapid disruption and thrusting up of hard rock into the air through the more modern stratified deposits, but to a very slow elevation, accompanied by much hard squeezing, and by very great denudation, erosion, and excavation; the whole of these latter results having been produced either by water, when at first the elevation was small, or by ice when it became considerable, and when glaciers in their progress towards the sea either filled the valleys that were already formed, or scooped out other valleys by their own eroding power.

There is no doubt that the work thus defined is very gigantic, and that the time needed for such work must have been extremely great. But, in the present state of geological science, it is admitted that time is absolutely demanded to account for all classes of phenomena. The evidence must be weighed and estimated according to its real value; and so far as the Alps are concerned, there is much evidence that has only recently been obtained whose value is very great.

Either the Alps have been formed in all their main outlines by convulsive elevations, or the grand outlines we see are merely the harder rocks left after the removal by denudation, erosion, or disintegration of the softer overlying and more modern strata. There are certain remarkable gorges in the Alps that at first sight seem to afford the strongest possible proof of the fracture theory, and these have generally been quoted as not admitting of any other explanation than is thus afforded. Certainly the traveller, in winding through the narrow gorge of Pfäffers, where the sky can scarcely be seen overhead, or in climbing the steep road of the Via Mala to the Splugen Pass, may well believe that the crevice he threads is the result of fracture or contraction, and that it has been formed in the rock originally during elevation, and is independent of all water action. Most of the wider valleys present evidence of water action; but these narrow gorges, if any, must be results of fracture.

Visiting this part of Switzerland with the view of examining into the point, Professor Tyndall has lately recorded, in the *Philosophical Magazine* for October last, the result of his summer excursion. He found on the slopes of the Via Mala stones rounded by water action, masses of detritus showing perfect stratification, and throughout the whole distance abundant proof that the whole cleft has been cut by the river, which now rushes along many hundreds of feet below. At the top of the pass is a plain, which is the bed of an ancient lake, and several other such lakes can be traced on the high plains of the adjacent passes. The Via Mala is certainly a water-worn fissure.

When we calculate the amount of gaping that would be produced within a given area by an elevation to the extent of the Alpine summits, it is clear that the valleys that exist cannot be explained by any such hypothesis. If they have been originally determined by cracks formed during upheaval, of which there is rarely proof, they have been so much modified by water action as to justify us in referring to that as the efficient agent.

It is chiefly in limestone that narrow gorges with vertical walls occur. In some of these, as in the *cañons* of the Colorado, described and figured in a recent number of the INTELLECTUAL OBSERVER, the water origin is very clear. In others, as in some of the valleys of the North of England, in the Alps and in America, long lines of caverns have been eroded and worn away by water till their roofs have fallen, and they offer deep open channels for water. Even where the rocks are less easily acted upon, but are unequal in their power of resisting water, curious crevices are formed through which water runs, or has

run, and which are in no sense the result of mechanical violence or upheaval.

The real aspect of the Alps, if fairly estimated, seems to offer nothing that cannot have been produced by denudation. Vast masses of sedimentary rock, of the older and middle periods, were once deposited horizontally over the granite which now forms the loftiest peaks of the chain. Gradually elevated, and as gradually denuded, all the softer and more yielding rocks have been swept off, to form the newer rocks far away to the north and south. Even when a deep fissure or gorge was originally a fracture, the water has since so completely done its work as to leave abundant evidence everywhere that all the actual forms and details are the result of its action, continued from the day when the torrent first began to wear away a channel, to the hour when it was last examined by the geologist or physical geographer.

Professor Tyndall has well illustrated this condition by remarking, that if an accurate model of the Alps were taken, a mould taken from it and inverted would exhibit broader and blunter mountains and narrower valleys than the model. In other words, much more has been removed than is left. It is physically impossible that the outline of the Alps, as we now see it, can be merely the result of contraction, fracture, upheaval, convulsion, or such like causes. The utmost possible allowance for cracks in such an operation, the sum of all the widths of all the cracks in a line a hundred miles in length, lifted 20,000 feet, would not amount to a quarter of a mile. The width of any one of the scores of valleys is well known to be greater than this. The area of the open fissures produced by disruption must be insignificant compared with that of the unfissured crust; whereas the area of the valleys is far larger than that of the peaks and mountain-summits. There is really no reasonable explanation of this very patent fact, without assuming denudation to have carried away enormously more than it has left; and unless we suppose the needles of hard rock, and the prominent and picturesque peaks and ridges, to be but the less destructible remains of all that was once there, we must give up the attempt to explain rationally the phenomena before us.

But if it be granted that water, during the elevation of a mountain chain, and while it is yet beneath the waves, carries off by its mechanical power in a fluid state whole piles of strata, comparatively soft as they emerge slowly from the deep; or if, when all that is left is gradually more and more lifted, a large portion is pared away by rain and river action,—what must we say to another and very different action of the same substance, when, in spite of all that the waves and the rain and the stream

can do, lofty mountains have struggled into existence, jagged peaks and open valleys being formed, and the elevation being great enough to secure a temperature in which ice formed in winter can accumulate from year to year, without being destroyed by summer heat? The circumstances under which ice will thus become a part of the mountain system, must depend on the climate of the locality; but the ice once formed above, will move down into the lower regions, and there continue to advance till a balance is struck.

Ice, under such circumstances, is a glacier. It moves, as we have said, like a tenacious fluid, adapting itself in some measure to the walls of rock within which it is shut in. But it rubs both the walls themselves and the bottom over which it passes; for it is not only solid, but contains innumerable rocks and stones, often large and heavy, and with these it erodes and excavates to an extent and in a way which fluid water can never accomplish. The motion is slow, but continuous. It is, however, variable, and in different parts of the same glacier is often altogether different. From a few inches to a few feet per day is an ordinary rate. But with this motion it can carry away obstacles very effectually, as is seen in the Alps and in all other glacier mountains.

We may well admit that ice can scratch and even tear up and destroy rocks in moving over them; but a mere study of glaciers, as they now exist in Europe or even in the Himalayan chain, would hardly enable us to understand what moving rivers of ice are capable of doing under favourable circumstances. We must revert to geological observations to discover this. In the Alps, where there is proof of glaciers having existed formerly, whose extent in length alone was more than fifty miles—when we see and measure the vast accumulation of moraines or glacier-gravel, and the magnitude of the blocks moved, we begin to understand that the force is a very active one. But still it seems a bold assertion that ice, and ice alone, has scooped out deep hollows, in some cases below the level of the Mediterranean; that the great lakes, not only those of Switzerland and North Italy, but even those of North America, are due to the same cause, and that generally we must look to ice as having greatly helped to produce the existing physical features of the temperate zones.

It is objected to this view (1), that ice does not erode and excavate, under ordinary circumstances, at its extremity, but, on the contrary, sometimes rides over an ancient moraine without removing it; (2), that it must, therefore, be yet more powerless to excavate a deep hollow; and (3), that it must be almost if not quite impossible that ice should first excavate and then rise out of a deep hollow, on its way from the moun-

tain to the sea. But these objections, though fair and powerful, are not unanswerable. Though it is true that some glaciers do ride over moraines, it is equally true that other glaciers cut out hollows and remove natural obstacles. The snout of a glacier, too, is its weakest part, not its strongest. The same glacier which, in some parts of its course, presses with a weight of ten tons on the square foot, and moves at the rate of twelve inches per day or more, will at another part near its extremity have scarcely a calculable motion and an extremely small pressure. The excavation will be made where the moving force is greatest, and the deposit where it is smallest. Thus a glacier may easily be pushed up-hill over its own moraine. The lake basin need not be excavated by the extremity, but rather by the body of the ice; and lakes not in rocky basins may be and are occasionally formed in this way.

The excavating effect of ice is not to be looked for on the hardest but on the softest part of the surface it travels over. It is when a gigantic mass of ice, coming from a great height, and pressed onwards by enormous weight, traverses a wide and comparatively flat space, crossing it entirely, and dying away at a distance beyond, that we must look for the chief effect; not when the ice merely enters the valley, and is melted at the first contact with it.

And, thirdly, the emergence of the ice from a deep hollow, even of 2000 feet or more, ceases to be impossible, or even difficult, when the distance is sufficient. The deepest part of the Lago Maggiore is about 2600 feet, and the distance to the outflow of the lake twelve miles. The rise is, therefore, one in twenty-four, or an angle of 2° 21′, which is a slope that could hardly be recognized by the most practised eye. The case of the Lake of Geneva, which has been mentioned, is another example; but the depth there is not half as great, and the distance more than double. This is an angle of 25′, and is practically horizontal.

At any rate, it is certain that the great lakes of the world have not been proved to lie in the axis of geological disturbances, either in faults or synclinal lines. Many of the most important, as Lake Superior and Lake Ontario, certainly do not. And how, then, can they be explained? The mere action of moving water can hardly plough out the bottom even of a shallow lake. In limestone districts, water running underground may sometimes eat away the rock, and the roofs of a succession of caverns falling in may produce a kind of channel; but these cases are limited, and certainly would not account for many lakes of large size. Even if they follow lines of least resistance, the whole excavation has been by ice or water, and of the two ice affords the most reasonable explanation.

But if this view of the influence of ice and water is true for the latest geological period—if the Alps, the Himalayan mountains, the Andes, and other mountain chains are thus mere salient points of the most recent elevations, once covered with great thicknesses of strata washed away during these gradual elaboration of the chain, what are we to say of the more ancient mountains—the results of elevation when the earth was younger? The answer is at hand. Such mountains are now worn away yet further. In many places they are low ridges; in many they are absolutely pared flat. The ancient chains of Europe, the Scandinavian chain, the Welsh and Scotch mountains, and the mountains of the Salurian or Devonian periods, are barely recognizable. The denudation has here completed its work, and has not stopped while anything remained to carry away. There are many extensive tracts where crystalline rock, flat and hardly above the sea-level, was once, perhaps, the floor of a mountain chain, not less lofty or less picturesque than the Alps. The sea first, then the rain and air, and afterwards the ice, have all in turn helped to pare away, undermine, and remove every prominence. Reduced at last from mountain masses to mere shreds of hills, these also at length have given way when the oscillations of level have not been sufficient to shelter the remains of the inequalities before they were quite destroyed.

The modern doctrines of the action of water and ice are, after all, only an extension of the views set forth long ago by the fathers of modern geology. Hutton, and his interpreter, Playfair, gave similar explanations, so far as water is concerned, though in their time the influence of ice was not recognized, and the work done by glaciers and icebergs had hardly been imagined.

[Note.—It must not be supposed from some expressions in this paper, that Professor Ansted intends to assert that glacial ice is really (as was once supposed) a viscous body. Faraday's discovery of regelation explains how the glacier flows. He found that if moist ice at 32° is broken, the fragments will instantly freeze together if placed in contact. Professor Tyndall says, "Thus a wheel of ice might be caused to roll on an ice surface, the contacts being incessantly ruptured with a crackling noise, and others as quickly established by regelation."—Ed.]

## ZOOLOGICAL CLASSIFICATION.*

THE progress of comparative anatomy and physiology has resulted from two circumstances: first, the number and variety of creatures that have been carefully examined, is enormously larger than it was a few years ago; and secondly, the examination has, in many instances, been more accurate and profound. At an early period of the study of fossils, the points of resemblance between extinct and living forms could not fail to be noticed, and the first triumphs of scientific interpreters in this department were won through the application of empirical laws, resting upon a very limited range of known facts, in accordance with which it was assumed that if any one character could be distinctly determined, a clue was afforded to the whole nature and structure of the creature under consideration. No one, except upon the ground of an obvious or fancied convenience, pretended to know why a particular form of hoof, tooth, or horn was found associated with special peculiarities of the skeleton, a definite structure of limbs, a certain kind of covering super-imposed upon the true skin, or the adaptation of digestive organs to particular kinds of food; but certain characteristics were found to be associated in all known cases, and hence, though without adequate reason, a strict and never deviating uniformity of rule was inferred. There can be no doubt that many observers have greatly over-estimated the probability of rules or laws of an empirical kind proving to be universal and invariable, and it has also been customary to push the doctrine, that structure and special utility always go hand in hand, much too far. More complete research has thrown discredit upon the assumption that the rule we see observed in *many* cases is necessarily maintained in *all* cases; and no anatomist of competent information would seek to elucidate all structures by arguing upon the assumption that the habits which creatures were intended to have, determined the precise nature of the organs they should possess.

In surveying the natural world, men are rarely, if ever, justified in taking it for granted that the only possible mode of accomplishing a result is that which they see adopted in certain cases. They may be quite right in asserting that it is the only mode consistent with particular conditions; but

* *Lectures on the Elements of Comparative Anatomy*, By Thomas Henry Huxley, F.R.S., Professor of Natural History, Royal School of Mines; and Professor of Comparative Anatomy and Physiology to the Royal College of Surgeons, England. *On the Classification of Animals, and on the Vertebrate Skull.* Churchill and Sons.

beyond this they cannot safely go. In attempting to explain the structure of animals by the doctrine of final causes, there is a constant tendency towards the assumption of knowing all about it, when, in plain fact, some of the conjectures may be doubtful, and others readily capable of disproof. True science does not attempt to resolve the question of why the universe, or anything it contains, was made in a particular way. Our intellectual vision is limited to so minute a portion of the whole, that such an inquiry is beyond our reach. But we may successfully exert ourselves in endeavours to ascertain *how* certain things are made, and what work they perform; and when Natural Theology takes possession of the facts of science, its most reverent and rational course is to learn as much as it can of the wisdom, the order, and the benevolence of the wondrous plan, without pretending to be acquainted with principles that could only be deduced from a knowledge of the whole range of antecedents that led to particular consequences, and with the ultimate results which such consequences will entail. Well does Professor Huxley exclaim, "For any reason we can discover to the contrary, that combination of natural forces which we term life might have resulted from, or been manifested by, a series of infinitely diverse structures; nor, indeed, would anything in the nature of the case lead us to suspect a community of organization between animals so different in habit and appearance as a porpoise, a gazelle, an eagle and a crocodile, or a butterfly and a lobster." In another passage he thus comments upon the methods of reasoning which, in the hands of Cuvier and his followers, have led to many valuable results, and likewise tempted many incautious thinkers into much false philosophy. "If," says Professor Huxley, "a fragmentary fossil be discovered, consisting of no more than a ramus of a mandible, and that part of the skull with which it articulated, a knowledge of this law—(correlation)—may enable the palæontologist to affirm, with great confidence, that the animal of which it formed a part suckled its young, and had non-nucleated red blood corpuscles; and to predict that, should the back of that skull be discovered, it will exhibit two occipital condyles and a well ossified basi-occipital bone. Deductions of this kind, such as that made by Cuvier in the famous case of the fossil opossum at Montmartre, have often been verified, and are well calculated to impress the vulgar imagination, so that they have taken rank as the triumphs of the anatomist. But it should be carefully borne in mind that, like all merely empirical laws, which rest upon a comparatively narrow observational basis, the reasoning from them may at any time break down. If Cuvier, for example, had had to do with a fossil *Thylacinus* instead of a fossil opossum, he would not have found the marsupial bones,

though the inflected angles of the jaw would have been obvious enough. And so, though practically any one who met with a characteristically mammalian jaw would be justified in expecting to find the characteristically mammalian occiput associated with it, yet he would be a bold man, indeed, who should strictly assert the belief which is implied in this expectation, viz., that at no period of the world's history did animals exist which combined a mammalian occiput with a reptilian jaw, or *vice versâ*."

Classification may be either natural or artificial; that is to say, it may be founded upon considerations of wide and enduring import, or upon others of a trivial and accidental kind. For a classification to be natural and rational, it should include, under the same head, objects which have some distinctive property or structure in common, which is not possessed by other objects, and which is important as well as characteristic. A linear arrangement, in which every object that is placed a degree higher or lower in the scale is really superior or inferior in capacities or development, is impossible, because nature does not work in this simple mechanical way. Nevertheless, in attempting to classify the animal kingdom, it is most natural to begin at one end or the other, either with the most important members of the mammalian group, or with the simplest organisms in which the lowest kind of animal life can be traced. It is curious to note the connection between size and development. For example, the lowest forms are all small, and the highest that we are acquainted with very far from being the biggest in dimensions. The simplest known animals, the *Gregarinida*, "are all microscopic, and any one of them, leaving minor modifications aside, may be said to consist of a sac, composed of a more or less structureless not very well defined membrane, containing a soft semi-fluid substance, in the midst or at one end of which lies a delicate vesicle; in the centre of the latter a more solid particle." Professor Huxley appends to this description the obvious, but highly important reflection, that its statements are all true concerning the ova of any of the animals much higher in the scale. The *Gregarinida* inhabit the bodies of other animals, and they multiply by becoming encysted and dividing into a multitude of minute objects, called *pseudo-navicellæ*, from their resemblance in shape to the ship-like diatoms (*Naviculæ*). When a young pseudo-navicella escapes, it behaves somewhat like an amœba, and if lucky enough to get swallowed by an appropriate host, it grows into the parent form. The whole life-history of these creatures is not known, as they have not been traced into the exhibition of sexual properties; and it is therefore possible that their position in the scale may not be

exactly what it seems. Next to these animals Professor Huxley places the Rhizopoda, with a note of interrogation indicating doubt. In former numbers of the INTELLECTUAL OBSERVER* many descriptions of animals of this class will be found, and especially of the interesting forms of Amœba, so well studied by Dr. Wallich, to whose labours Professor Huxley does not allude. The rhizopod, whether naked or inhabiting a beautifully-constructed shell, is a little mass of jelly-like material. It can put forth processes which answer many of the purposes of organs and limbs. It can flow round and inclose particles of food, and its substance may, as Dr. Wallich has shown, take the form and condition of *ectosarc* or *endosarc*, according to whether the movements of the sarcode bring particular portions to the surface, or carry them into the interior. A reference to the description of the *Amœba villosa*—a term which, although not indicating a species, is applicable to a condition—given in vol. iii. p. 430, will show that some members of the group possess permanent organs; and Dr. Wallich ascertained that in some cases the nucleus was inclosed in a distinct membrane. He also found reason for supposing that he had detected germ cells and sperm cells in some of his specimens. It is customary to regard the lowest rhizopods as homogeneous structureless sarcode; but further investigation may modify this view.

In sponges, which very much resemble colonies of amœbæ, sexual reproduction has been traced. "Individual sponge particles," says Professor Huxley, "become quiescent, and take the character of ova; while in other parts, particular sponge particles fill with granules, the latter eventually becoming converted into spermatozoa."

Next the sponges Professor Huxley places the unassorted group commonly called Infusoria. Organisms of very different degrees of development are associated under this inappropriate term, and nothing distinctive, of this group only, can be predicated of them all. They will, no doubt, have to be distributed amongst different groups; and when Professor Huxley instances the contractile vesicle and its associated canals as "eminently characteristic of the Infusoria," we may ask whether the water-vascular system of intestinal worms and rotifers is not of so analogous a nature as to take away the distinctive characters he appears to claim. From the Infusoria we pass to the hydra-like Polyps, from them to the Actinozoa (or anemones, etc.), then to the Polyzoa, of which the *Plumatella repens*, described in the INTELLECTUAL OBSERVER, vol. ii. p. 271, may be taken as a type.

In the Polyzoa, a distinct nervous system is recognized,

* Vol. iii. p. 20. *Ib.* 430.

but no heart; "the matters which result from digestion percolating through the walls of the intestines, and becoming mixed with the perivisceral fluid." It is remarkable that in these creatures the intestine is curved like the letter U, so that the anus is bent round to approach the gullet. The nervous ganglion is placed between the two legs of this flexure, and a bend of this kind is called "neural."

The Polyzoa are all compound or associated animals, whence their name; but when a polyzoon egg is hatched, as in the case of the Plumatella described in our vol. ii. p. 271, it commences life as an isolated being, and by a subsequent growth, resembling budding, multiplies into a colony.

The Brachiopoda (lamp shells), which bear considerable resemblance in structure to the Polyzoa, are, like the higher animals, not capable of this colonial multiplication—their only offspring living as single creatures, like their parents. "In this family the intestine," says Professor Huxley, "either ends blindly in the median line, or else terminates in a distinct anus." A similar statement might be made concerning the Rotifers, as while a distinct anus is usual, in the Asplanchna the digestive cavity terminates in a *cul de sac*. The Brachiopoda, like the Ascidians, possess what is called an "*atrial* system," or set of canals distinct from the true vascular system. Professor Huxley adopts the view that these atrial vessels carry away excretory matters, and the products of the reproductive organs. In the former of these functions they appear to resemble the water-vascular vessels of the Rotifera, to which excretory, as well as respiratory, functions, may probably be assigned.

In the Ascidians the atrial system is remarkably developed, and is in free communication with the pharynx, "and as on the margins of the pharyngo-atrial apertures are fringed with cilia, working towards the interior of the body; a current is produced which sets in at the oral aperture, and out at the atrial opening, and may be readily observed in a living Ascidian." Small young transparent specimens afford beautiful spectacles with a moderate magnification. In the Ascidians, the first bend of the intestine would carry it *away* from the nervous ganglion. This kind of flexure is termed *hæmal*, and the relative positions of the nervous and blood systems will be found to possess great distinctive importance.

We need not dwell on the Lamellibranchiate animals because they will be better understood by referring the reader to the Rev. Mr. Haughton's paper on the "Swan Mussel," No. xxxii. p. 67. In these creatures a well developed heart is found, and the gills, arranged in "lamellæ," or leaves, furnish beautiful microscopic objects, in which ciliary action

is most interestingly displayed. The nervous system of these creatures exhibits a decided advance, there being at least three pairs of principal ganglia. Animals like the whelk, the pteropod, and the cuttle fish, each carry the progress of development still further, and prepare the way for the vertebrate group.

A great number of animals not yet spoken of must be arranged somewhere in groups parallel with some of those to which allusion has been made. Amongst these, the *Echinodermata*, of which the star-fishes may be taken as an example, form a clearly distinct group. Animals of this kind begin life by being hatched from an impregnated egg, and their first appearance is usually in the form of a free swimming ciliated embryo, which undergoes changes of a remarkable kind. Some echinoderms possess a continuous calcareous skeleton, while others, like the sea-cucumber, are without it; but have their integument strengthened and defended by a multitude of detached plates, or spicula. The larvæ of these creatures soon develope a distinct alimentary cavity, "divided into a well-marked oral and œsophagal portion, a globular stomach, and a short intestine terminating in an anal aperture."

The life changes of the echinoderms are too complicated and curious to be incidentally treated, we shall, therefore, in this place pass them over, and observe that in adults the mouth is found in the middle of a "circular vessel" and "vessels which radiate from the latter give off diverticula to communicate with the cavities of numerous processes of the body—the so-called feet, which are the chief locomotive organs of the adult. The radiating and circular vessels, with all their appendages, constitute what is known as the ambulacral system, and in asterids (star-fishes), and in echinids (sea hedgehogs), this remarkable system of vessels remains in communication with the exterior of the body by canals connected with perforated portions of the external skeleton—the so-called madreporic canals or tubercles." "The nervous system in all adult echinoderms exhibits a ring-like, or polygonal gangliated cord, situated superficially to that part of the ambulacral system which surrounds the mouth, and sending prolongations parallel with and superficial to the radiating ambulacral trunk." Professor Huxley adds that the alimentary canal is less dependent upon the form of the skeleton, and only in one group, the *Asteridea*, shows anything approaching to a radial disposition. The vascular system "is closely related to the alimentary and ambulacral systems," but the details have not yet been made out.

Professor Huxley next considers seven groups, which he has provisionally placed under the head *Scolecida*. This term

will be understood by those who perused a recent article which we published, founded on Dr. Cobbold's magnificent work.* The first group of Professor Huxley's Scolecida is formed of the Rotifers, several of which have been described in our former number. Then follows the Turbellaria, the Trematoda, or Flukes, concerning which our subscribers will find much in papers by Dr. Cobbold † which we have already laid before them: and we may make the same remark concerning the Tæniadæ, or tapeworms, while the Nematoidea, or round-worms, and the Acanthocephala and the Gordiacia have been alluded to in a number already cited. The first four of these groups exhibit the water-vascular system in a striking way; and Professor Huxley says, "In none of these animals has any other set of vessels than those which appertain to the water-vascular system (if I am right in my view of the vessels of the Nemertidæ) been observed, nor has any trace of a true heart been noticed." The nervous system consists of one or two closely approximated ganglia. Professor Huxley considers that the Rotifera, the Turbellaria, Trematoda, and Tæniada, must be placed in one great assemblage; and that if certain vessels seen in the nematoid worms are homologous with the water vessels of the Trematoda, they must be added to the group, with a probability of carrying with them the Gordiacea and the Acanthocephala.

The value of this arrangement will depend upon the opinion that is finally formed concerning the importance of the water-vascular system, as affording a sufficient characteristic for associating together animals so different as a rotifer, with an elaborate digestive apparatus, including a very remarkable masticatory apparatus, and a tapeworm, which has no mouth and no digestive canal. The tapeworms likewise exhibit the phenomena of alternate generation, the union of the sexes in the same individual in its perfect form; while the rotifers have no alternate generation, no sexless condition, and exhibit male and female organs in distinct individuals.

Professor Huxley confesses that the division provisionally termed Scolecida is in an unsatisfactory state, and it seems to us that farther researches into the nature of the contractile vesicle and canals of the Paramecia and other ciliated infusoria are necessary before the value of the water-vascular system as a ground of classification can be decided upon.

The Annelida, comprehending the leech, earthworm, lobworm, sea mouse, etc., all possess a nervous system, which consists of a longitudinal series of ganglia, situated along one side of the body; "but no annelid ever possesses a heart com-

* No. xxxiii., p. 190.

† Vol. i. pp. 2, 115, 347; vol. ii., p. 82; vol. iii. p. 86; vol. iv., p. 390.

parable to the heart of a crustacean or an insect; but a system of vessels, with more or less extensively contractile walls, containing a clear fluid, usually red or green in colour, and, in some rare cases only, corpusculated, is very generally developed, and sends prolongations into the respiratory organs when such exist." Professor Huxley likewise states that "the embryos of annelids are very generally ciliated, and vibratile cilia are commonly if not universally developed in some part or other of their organization." "In both these respects," he adds, "they present a most marked contrast to the succeeding classes."

In the Crustacea the body is distinguishable into a variable number of "somites" or definite segments, each of which may be, and some of which always are, provided with a single pair of articulated appendages . . . a pair of ganglia is primitively developed in each somite," and "no trace of a water-vascular system, nor of any vascular system similar to that of the Annelida, is to be found in any true Crustacean."

With considerable resemblance to some Crustaceans, the Arachnida—scorpions, mites, and ticks—never possess more than four pairs of locomotive limbs, and the somites of the abdomen are not provided with limbs. The Myriapoda, or centipedes, have more than twenty somites in their bodies, and "those which correspond with the abdomen of Arachnida are provided with locomotive limbs." The Insecta have tracheal respiratory organs like the Myriapoda, "with a nervous and circulatory system disposed essentially as in this and the two preceding classes; but the total number of somites of the body never exceeds twenty;" and in the adult stage, the abdomen is never furnished with locomotive limbs.

The vertebrate animals consist of five classes: Fishes, Amphibia, Reptiles, Birds, and Mammals. In a diagrammatic* representation of a cross section of the higher invertebrate animals, they are depicted as single tubes, in which are contained the alimentary system, occupying the centre, the nervous system above it, and the heart, or vascular system, below. In Professor Huxley's words, "the external or integumentary and parietal portion of the blastoderm† never becomes developed into more than a single saccular or tubular investment, which encloses all the viscera; . . . . but in the five vertebrate classes, the parietal portion of the blastoderm of the embryo always becomes raised up, upon each side of the middle line, as a ridge, so that a long groove is

* An anatomical or physiological *diagram* illustrates a principle of construction. It is not a *likeness* of any one thing.

† Literally "germinal skin or membrane," the covering of the matter which grows into an embryo, or of the embryo itself.

formed between the parallel ridges thus developed, and the margins of these, eventually uniting with one another, constitute a second tube parallel with the first, by a modification of the inner walls of which, the vertebrate cerebro-spinal nervous centre is developed. Hence it follows, that after any vertebrate animal has passed through the very earliest stages of its development, it is not a single, but a double tube, and the two tubes are separated by a partition which was primitively a part of the external parietes of the body, but which now lies in a central position between the cerebro-spinal nervous centres and the alimentary canal." Hence a diagrammatic and transverse section of a vertebrate animal exhibits two tubes, one containing the alimentary canal, the heart and certain nervous centres belonging to the so-called sympathetic system, and the other containing the cerebro-spinal tube, "which appears to be a superaddition—a something not represented in the invertebrate series." Several other highly important differences separate the vertebrates from the invertebrates; but shall now only mention that a vertebrate animal never has more than two pairs of limbs, that it has a distinct vascular system containing blood, "with suspended corpuscles of one kind, two kinds, or even three distinct kinds," and its jaws are modifications of the cephalic parietes, and do not resemble the masticatory apparatus of the invertebrate, which are "either hard productions of the alimentary mucous membrane, or modified limbs."

It is remarkable that not only do the early condition of the vertebrates mark them out from the invertebrates, as just explained, but peculiarities of this condition also distinguish the vertebrates from each other. Before we give any illustration of this we will copy from Professor Huxley a lucid description of the *amnion* and the *allantois*. "The amnion," he says, "is a sac filled with a fluid which envelopes and shelters the embryo during its slow assumption of the condition in which it is competent to breathe and receive food from without. . . . The allantois is developed much later than the amnion, neither from the serous, nor from the mucous (or epidermic and epithelial) layers of the germs; but from that intermediate stratum whence the bones, muscles and vessels are evolved. It arises, as a solid mass, from the under part of the body of the embryo, behind the primitive intestinal cavity; and, enlarging, becomes a vesicle, which rapidly increases in size, envelopes the whole embryo, and being abundantly supplied with arterial vessels from the aorta, serves as the great instrument of respiration during fœtal life." In the bird, "the porosity of the egg-shell allows the allantoic blood to exchange its excess of carbonic acid for oxygen by osmosis."

No fish, the Professor tells us, exhibits any trace of an amnion; the amphibia (frogs, etc.) have no amnion, and the urinary bladder is the only representative of the allantois. Amphibia and fishes have many points of resemblance; the former at some period, and the latter at all periods, have organs adapted for aquatic respiration, which is not the case with the vertebrates above them. Amphibia which possess limbs, exhibit in their structure a resemblance to those of the higher vertebrates, not shown by any fish. "In all amphibia the skull articulates with the spinal column by two condyles, and the basi-occipital remains unossified. Furthermore the cranial peduncle, or suspensorium, to which the lower jaw is articulated, gives attachment to the hyoidean apparatus. These last are characters by which the amphibia are sharply distinguished from the higher vertebrates."

The length to which this paper has already attained precludes our entering into the details by which the upper classes of vertebrates are separated from each other. We still find grounds of distinction in the early stages of their existence, and all above the fish and amphibia possess a well-developed amnion and allantois. Birds and reptiles, which at first sight appear so thoroughly distinct, approach each other on examination; so that Professor Huxley and other comparative anatomists consider birds as an "extremely modified and aberrant reptilian type."

The mammalia stand at a considerable distance from the birds. All possess an amnion, and all are allantois; "but the latter ceases to exist after a very early period, or else it is placentiferous, and serves as a means of intercommunication between the parent and the offspring. . . . The visceral arches are throughout life as completely devoid of branchial appendages in mammals as in birds and reptiles." The occipital condyle is not single as in reptiles and birds, but double, and each ramus of the lower jaw is composed of a single piece, articulated directly with the squamoral bones of the skull. "The greater or lesser circulations of mammals are as completely distinct as in birds, and there is but a single aortic arch, the left. The majority of the blood corpuscles are red, free nuclei, and these are always discoidal and usually circular. The blood is hot. There is a complete diaphragm and none of the bronchi end in air sacs," as is the case with birds. All mammals secrete milk.

We shall recur to Professor Huxley's book on another occasion. Few, if any, names could be mentioned which deserve to stand higher among the present race of English scientific men than his. He is amazing in industry, comprehensive in knowledge, and exact in observation. Moreover,

he possesses in a very high degree a devotion to truth. We have no one extant among us who surpasses him, and few who come near him, in that enviable quality of being able to use an hypothesis without becoming a slave to it. He is ardent in his sympathies with what appears to be a wide and sound generalization; but always on the look-out for any unexpected fact that might contradict it. We wish he would give up his life-long quarrel with Owen, whom he has distanced in science as well as convicted of error. We believe those who admire him most are really sick of this squabble, and he should not let it haunt him as King Charles' head haunted Mr. Dick.

The *Elements of Comparative Anatomy* promises to be one of the greatest scientific works of our time; but we can't help feeling that its author wants leisure to make the best of his materials. Successive courses of lectures, published at intervals, do not, and cannot, make the most complete work. If there be, however, blame for not doing better, it rests not with Professor Huxley, but with our so-called state of "civilization." Every one able to form an opinion on the subject, has long seen that in Mr. Huxley we had our best opportunity of taking a high stand in Comparative Anatomy and Zoology. Of our rising scientific men he was the most likely to furnish a goodly supply of new truths in his department, and to connect them with each other, and with old truths, by a philosophy at once cautious and comprehensive. Our society, in its collective capacity, found out enough of this obvious fact to enlist his services in an educational department: but it imposed upon upon him a preposterous quantity of work for a ridiculous quantity of pay. To do justice to his own powers, and conduce most highly to the intellectual development of his country, fair remuneration and sufficient leisure are palpable requisites. Our system leaves him no leisure; and as members of our ruling class saunter from their luxurious clubs, within a stone's-throw of the scene of his labours, they may do well to reflect that a man, whose name will live when theirs is forgotten, toils for a pittance far below the salary of a clever and fortunate cook.

# COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from Page* 300, *Vol.* vi.)

1273. On December 5, a new star appeared in the Hyades. It moved through Auriga, past $\theta$ and $\phi$ Ursæ Majoris, $\epsilon$ and $\rho$ Boötis, to Arcturus, and remained visible three weeks.—(Gaubil.)

1274. Three days before the death of St. Thomas D'Aquinas, a comet appeared.—(Guillelmus De Thocus, *Vita S. Thom. Aq.* x. 60.)

1277. On March 9, a comet 4° long was seen in the N.E. (Gaubil.)

1285. In this year a great comet appeared. Its tail pointed to the N.W.—(Ptolomæus Lucensis, *Historia Ecclesiastica*, xxiv. 17.) On April 5, a very brilliant star was seen in Bohemia.—(Pontanus, *Bohemia Pia.*)

1293 or 1294. In February '93 or January '94, a comet was seen in the circumpolar regions. It passed through the square of Ursa Major.—(Couplet, Gaubil.) On November 7, 1293, a comet appeared, as above. It was one degree long and lasted a moon.—(Biot.)

1298. Celestial signs announced the death of Beomond, Archbishop of Treves. [He died December 9, 1299.] In the preceding year a comet was seen during twelve consecutive nights, at about the third hour of the night. Its head was in the N. and its tail trended Southwards.—(*Archiep. Trev. Gesta.*)

1299. On January 24, a comet appeared below $\lambda$ and $\gamma$ Columbi.—(Biot.)

1301. [ii.] Before Christmas, a comet was seen in the W. after sunset. It set before midnight and lasted fifteen days. On December 1, it was in Aquarius and Pisces.—(Ricobaldi, *Compilatio Chronologica.*)

1304. On February 3, a comet was seen near $\alpha$ and $\beta$ Pegasi. It passed toward the circumpolar region, and by the tail of Cygnus, and Cepheus. It lasted eleven weeks.—(De Mailla, ix. 483.) Its tail was more than a degree long.—(Biot.)

1305. Three days before and three days after Easter, or from April 15—21, a great comet, with a long tail, was seen.—(Bothonis, *Chronica Brunswicenses.*)

1313. From April 13 or 20, a comet was seen near the feet of Gemini. It remained visible for a fortnight.—(Biot; Gaubil; Mussatus, *Historia Augusta*, xv.)

1314. In October [?], a comet appeared in the latter part of [the sign ?] Virgo, towards the N.—(Paulus Cygnæus, *Chronicon Citizense.*) The accounts are very vague and contradictory.

1315. On October 29, a comet was discovered in the regions lying around $\beta$ Leonis. On November 28, it was in the circumpolar regions. It then traversed the sidereal division of Corvus, and passed to the square of Pegasus. It remained in sight till March 11, 1316.—(Gaubil, Biot.) European writers say that two comets were visible from December, 1315, to February, 1316. The first was much larger and brighter than the second.—(Hagecius, *De Stellâ Novâ anni* 1571, etc., etc.) The N. P. D. of the larger one on December 25, at seventeen hours, was 18° 38′; on January 15, at seventeen hours, it was only 9° 49′.—(Mussatus, *De Gestis Italicorum,* vii. 14.) Those who speak of the second comet, say that it appeared in the E.—(*Chronicon Rotomagense.*) Can it be that after all there was only one?

1334. In August, a comet, with a tail seven and a half feet [degrees?] long, was seen.—(*Synop. Chronol.*)

1337. [ii.] A comet was seen in Cancer during the visibility of the great comet of this year. It lasted two months.—(Giovanni Villani, *Chroniche,* xi. 66.)

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## ARCHÆOLOGIA.

### EXCAVATIONS ON THE SITE OF THE ROMAN OTHONA, AND AT LEICESTER AND SILCHESTER.—DISCOVERY OF AN EARLY HILL SETTLEMENT IN SCOTLAND.—ANCIENT CANOE FOUND IN IRELAND.—FORGED ANTIQUITIES.

Excavations of considerable interest have recently been made upon several important sites, and some of them, now in progress, promise still more interesting results. The site of the first of these explorations is in Essex. Towards the close of the Roman imperial rule in Britain, three new fortresses had been raised to defend the coast from the mouth of the Thames to the Wash, then harrassed by Saxons and other marauders, which are enumerated in the *Notitia Utriusque Imperii,* under the names of Othona, Branodunum, and Gariannonum. The last of these is identified with the fine Roman ruins now called Burgh Castle, in Suffolk, and Branodunum is Brancaster in Norfolk; but Othona, which was garrisoned by a body of Fortenses, appeared to be entirely lost; it was supposed to have been submerged under the sea somewhere near St. Peter's Head, in Essex. It seemed the more surprising that the site of this station should have been so entirely forgotten, as it was a place of some

importance under the Anglo Saxons, who called it Ythan-ceaster, evidently a mere corruption of *Othonæ castrum*. When, in 653, St. Cedd preached the Gospel among the East Saxons, he was especially successful in this "city" (*civitas* is the word used by Bede), and built a church in it. Along this coast, the sea-line has undergone great alteration since the time of the Romans, and steps have been taken recently to reclaim a portion of the coast. In the course of these works, extensive remains of buildings have been found, presenting all the well-known characteristics of Roman masonry, which, there can be no doubt, are remains of the ancient Othona. The walls are massive, and of solid masonry, consisting of regular layers of ashlar, with the well-known rows of bonding-tiles. In the course of the excavations to bring these walls into view, Roman coins, chiefly of the Constantine family, Samian ware, and other descriptions of Roman pottery, glass beads, and other objects belonging to the Roman period, were found, but no object of any very great interest.

All who are acquainted with the interesting old town of Leicester, will remember that fine mass of Roman masonry, known by the name of the Jewry Wall, the only fragment of the Roman town of Ratæ now standing above ground. It consists of a long line of wall supported by a series of arches, so peculiar in its character, that many contradictory opinions have been held as to the nature of the building of which it originally formed a part. About a year and a half ago, some slight excavations were made which seemed to show that some of these opinions were without foundation, but threw no further light on the subject. More extensive excavations are now making under the directions of a Committee of the Leicestershire Architectural and Archæological Society. Already a tesselated pavement has been discovered at the northern extremity of the great wall, with a smaller wall running in continuation of that wall, but no buildings have been traced to the eastward of the great wall towards the church, the eastern side being that supported by the arches. We hope to be able on a future occasion to give a more complete account of the result of these excavations. It is proposed to uncover and expose to view the piers and arches down to the original level, and, after it has been permanently cleared from the rubbish, the wall will be protected by a pallisading.

We are also able to announce that excavations are in progress on the site of Silchester in Hampshire, the Roman Calleva, at the expense of the proprietor of the land, the Duke of Wellington. The Roman city was of very great extent, and many objects of interest have been found here at different times. It is little more than a fortnight since the present excavations have commenced, and little has yet been found except foundations of buildings and coins, but much is to be hoped.

To turn from these grand memorials of the Roman occupation of our island, we may notice the announcement, in the columns of the *Scotsman*, of the discovery of the remains of an ancient British town on the western side of Craigiehill, on the Linlithgow side of the Almond river. Many years ago, when cutting a road through Craigie-

hill, between Kirkliston and Cramond, the workmen came upon a stone cist, the end of which is still to be seen projecting from the bank over the carriage way. Several opinions have been expressed as to the nature and antiquity of this object, and some time ago Professor Simpson thought he had observed on the hill indications of an ancient British settlement. Permission has been since obtained from the proprietor to make explorations; and the excavators, after some search, came upon traces of three walls or ramparts, inclosing a space near the western top of the hill, upon which were numerous raised circular rings of stones, apparently the foundations of such dwellings as our "rude forefathers" are known to have occupied. On the following day Professor Simpson made a much more extensive and systematic investigation, the result of which was that it exposed portions of the faces of the three lines of walls, and one of the raised circles inside. They also discovered an opening which had formed one of the entrances to the encampment. The ramparts are arranged in a fortified manner, as parallels, and towards that part of the hill from which alone any attack could be made, the other sides presenting natural barriers which, in those times, no invading force could have hoped to overcome. Excavations were made behind the old stone cist, which would seem to have been placed just outside the walls, but nothing of interest was found there. Remains of ancient settlements of this description are found in many parts of Britain, but have not attracted much notice until a recent period. They deserve close examination, but from our present knowledge it would be very unsafe to pronounce any decided opinion on the period to which they belong. Roman remains have been found in some of those met with in the south of England.

Among the objects of great interest which are found not uncommonly are the canoes, or boats made out of the solid trunks of trees, which were used in the navigation of the rivers and lakes of our island at some remote period, probably at different periods, but we have no evidence as yet to show what that period was, or between what limits it extended. It is a case in which evidence founded on the depths at which these objects are found must be taken with great caution, because the boats themselves were heavy, and from the character of the locality in which they are found they would not have had any natural resting place, but must have sunk gradually in mud and a soft soil. A more than usually interesting discovery of this kind has recently been made in Ireland. "In the latter part of the past summer, as Charles W. Levinge, Esq., of Levington-park, Westmeath, and two of his sons were amusing themselves on Lough Owel, they perceived on the southern shore, adjacent to the island well known to sportsmen as Suthera Island, in five or six feet of water, a black mass of matter, which, on close scrutiny, proved to be a boat or canoe, of extraordinary length, in an almost perfect state. Rafts were subsequently constructed, and by means of a windlass it was safely floated to a convenient landing-place, and thence conveyed to Levington-park. The canoe is hewn out of one piece of solid oak; it is forty-two feet in length, spoon-formed at the bow, and flat at the stern; its breadth from gunwale to gunwale is forty-

two inches; outside breadth at bottom thirty-two inches; inside, twenty-nine inches; highest part of gunwale from edge of flat bottom, about eighteen inches. The interior structure presents still more singular peculiarities. In the bow commences a series of circular holes nearly opposite to one another, of about two inches each in diameter, which are continued right through the bottom in two rows, at intervals of about three feet asunder, until they reach the stern, which is marked by a groove of about one inch deep and four in width; these holes are twenty-two in number while a few inches sternward of these holes are two other large rows, pierced in an oblique direction, and somewhat on what may have been the water-line when the canoe was afloat. Eight of these holes still retain plugs of pine in a perfectly sound state. No marks of seats or convenience for rowing or propelling the vessel are discoverable."

On Wednesday evening, November the 23rd, at the first meeting of the season of the British Archæological Association, Mr. Syer Cuming, the secretary, exhibited a collection of forgeries of antiquities in bronze. They consisted of daggers, spear-heads, and other objects, pretending to be of different dates, and made of a mixed metal of little intrinsic worth, presenting to the sight the appearance of a rather light-coloured bronze, but melting at a low temperature. They are all represented as coming from the bed of the Thames. These bronze forgeries appear to have been first made only a few months ago. Early in the present year a bronze dagger, in the style of the *cinque cento* period, having an ornamental handle shaped in the form of a naked woman holding an apple in one hand, was offered for sale, and was so cleverly executed as to deceive several collectors. It was doubtful whether the female was intended for Eve or for Venus. We have seen more than one of them, apparently all cast from the same mould, and each recommended by the same story—namely, that it was drawn up from the mud of the Thames in the course of the works for laying the foundations of the new Westminster Bridge. This was a favourite story for some time with the vendors of these forgeries. Before the appearance of the bronze antiquities a quantity of very impudent forgeries in lead, especially of medallions, which betrayed themselves at once by the inscriptions, and especially by dates, which the forgers had rather imprudently placed upon them. These were represented sometimes as being dug up from the earth, and sometimes also as obtained from the Thames. When people were made tolerably widely acquainted with these forgeries, they were succeeded by the bronze daggers just alluded to, and the success of the latter has caused a considerable extension of this disgraceful traffic. The examples exhibited before the Archæological Association were inferior in make to the daggers formerly offered, and would not for an instant deceive a practised eye. It is very much to be regretted that some means cannot be found of putting a stop to these mischievous practices, which are now carried into almost all branches of archæology, and in some, as especially in the forgery of flint implements, which has been carried on to an extraordinary extent, they create much doubt and confusion even in science itself.

T. W.

## LITERARY NOTICES.

THE ASTRONOMICAL OBSERVER: A Handbook to the Observatory and the Common Telescope, by W. A. DARBY, M.A., F.R.A.S., Rector of St. Luke's, Manchester. (Robert Hardwicke.)—Mr. Webb's "Celestial Objects for Common Telescopes" has proved the forerunner of other works, more or less competing with it, in the endeavour to supply the guidance which amateur observers need in the use of their instruments. This is satisfactory, as leading to the belief that the number of workers with telescopes is largely on the increase, and that a consequent demand for more help is springing up. As Mr. Webb's book is not an expensive one, and takes in a greater range of topics than the volume before us, we should still recommend that every observer should obtain it; but while Mr. Darby does not appear to have selected his objects with so much personal care as Mr. Webb has displayed, there is a feature in his work which Mr. Webb's does not possess, and which will save students a vast deal of trouble, we mean the uniform carrying out of the plan adopted by Mr. Webb in the articles on Double Stars, etc., communicated to our pages, of giving alignments from conspicuous stars to the special objects described. Of course all compilers and describers of double stars are deeply indebted to Admiral Smyth, whose catalogues remain as invaluable authorities; but beginners, and those who have only small telescopes at their command, need a less voluminous list of objects they are likely to find without an equatorial, and likely to see with instruments of from two to four inches aperture, and with moderate magnification. Mr. Darby commences his work with a well-written "Introduction," containing a good deal of information necessary to start an observer, with or without an equatorial. He then gives a list of Double Stars selected as test objects by Admiral Smyth. Then follows a list of nebulæ and clusters that make good test objects; then we have refraction tables, a list of constellations, with their positions on the 1st of each month at nine p.m.; after which comes another valuable table of the approximate mean times when the principal stars are due east or west of a spectator in lat. 50° on the 1st of each month, and this part of the work concludes with Mr. Chambers' list of variable stars.

The constellations are then noticed in alphabetical order. The general form of the group and the position of the chief stars is given, together with the date when the constellation rises, culminates, and sets, and the names of the adjacent bounding constellations. Following these introductory remarks is a list of nebulæ, and then one of double stars. The R. A. and D. will suffice for those who have equatorials, and, for those who do not possess them, the task of finding is facilitated by pointers and alignments. It would be a great advantage to students if Mr. Darby would compile a good set of alignment maps to accompany his treatise. Even better than a set of maps would be a movable planisphere sufficiently large to take in the chief objects in his list. Mr. Darby's book is well cal-

culated to aid both beginners and more advanced students; but we should recommend the former not to trouble themselves with the nebulæ, or with stars of smaller size or greater approximation than about three seconds, until they have acquired considerable practice with easy objects.

Lecture on the Education of Girls, considered in connection with the University Local Examination, by W. B. Hodgson, LL.D., F.C.P. (Emily Faithfull.)—This is an admirable paper, which we cannot too strongly commend. Those who wish to promote that most desirable object of encouraging a sound education for the usually neglected half of human kind, will not easily discover a better mode of action than by purchasing a few copies of Dr. Hodgson's lecture to lend amongst their friends. It is not a flattering illustration of what we are pleased to call our stage of "civilization," that a man of Dr. Hodgson's attainments should be obliged to labour in defence of what ought to be a self-evident truism—namely, that girls as well as boys are entitled to a training calculated to develope all their faculties. We know, however, that this task is really necessary, and it will require a strong effort on the part of sound thinkers and vigorous writers to popularize rational ideas on the subject, and make them prevail.

British and Garden Botany; comprising Descriptions of the Flowering Plants, Ferns, and Trees indigenous to Great Britain, with notices of all the Plants commonly cultivated in this country for Use and Ornament, preceded by an Introduction to Structural and Physiological Botany, by Leo H. Grindon, Lecturer on Botany at the Royal School of Medicine, Manchester, Author of the "Manchester Flora," "Life, its Nature, Varieties, Phenomena," etc., etc. (Routledge.)—This is a very handsomely got up octavo volume of 869 pages, illustrated with a considerable number of well-executed woodcuts. It must be admitted that Mr. Grindon has produced a book that ought to be popular, as it is sure to be useful. We think he has attempted too much, but he has performed a great deal very well, and in an interesting manner. He has a clear perception of the difficulties students feel in commencing the study of botany, and endeavours to meet them by a simple, intelligible mode of treating his subject. With a very moderate amount of pains any one may learn from his pages to recognize the characters of the principal families into which plants are divided, and also to distinguish many genera and species; but we doubt whether the mere mention of hundreds of names and localities will prove of much use. We are glad to observe that the book is bound with considerable elegance and good taste.

The Astronomical Register. (Adams and Francis.)—Successive numbers of this monthly periodical show that its editors are supplying a want felt by the cultivators of observational astronomy, and at the same time furnishing a useful channel of intercommunication. We are glad to see that it is supported by many of our ablest observers.

HOMES WITHOUT HANDS; being an account of the habitations constructed by various animals, classed according to their principles of construction, by the Rev. J. G. WOOD, M.A., F.L.S., author of the "Illustrated Natural History," etc., with very numerous illustrations engraved on wood by G. Pearson, from original drawings made by F. W. Keyl and E. A. Smith, under the author's superintendence, expressly for this work. (Longmans.)—Mr. Wood is at infinite pains to keep up the interest of his work, which we commend very heartily, as it is sure to excite a taste for natural history pursuits. Birds, beasts, and insects all figure in his pages, grouped together according to the kind of dwellings they construct. He tells many a marvellous tale of instinct and sagacity which cannot fail to fascinate as well as to instruct, and his illustrations are admirable in quality as numerous in quantity. When the monthly parts are complete they will form a beautiful work of permanent interest.

THE CANADIAN NATURALIST AND GEOLOGIST, with the Proceedings of the Natural History Society of Montreal. (Montreal: Dawson Brothers. London: Ballière.)—The numbers we have received of the new series of this publication evince an amount of scientific activity in Canada that is not only highly honourable to the colony, but also calculated to promote its industrial development. For questions of geology, local natural history, and allied subjects, the "Canadian Naturalist" must be referred to as an authority, as its principal contributors have already taken a good position in the scientific world. The papers are well written, and must encourage scientific tastes. The geology of Canada is of great interest, both on theoretical and practical grounds, and we may ascribe the impulse that has been given to intellectual pursuits in the colony to the zeal and talent displayed by the members of the Government Survey.

THE ANTHROPOLOGICAL REVIEW, AND JOURNAL OF THE ANTHROPOLOGICAL SOCIETY OF LONDON. No. 7. (Trübner and Co.)—The present number contains some interesting notes by Captain Burton on "Waitz's Anthropology." They are written in intelligible English, which their author can employ when he thinks proper to abandon the tedious and wretched jargon in which so much of his book on Dahome is composed. Of course we have his customary defence of slavery, but we have also his learning and acute thought. "Bain on the Senses and the Intellect" is decently reviewed, then follows a paper on the "Gipsies of Egypt, and the Idea of Species as applied to Man," and an article on "Slavery," displaying no ability, and apparently intended to show how mildly the Anthropological Society is disposed to view that great sin and crime. Mr. Bollaert contributes a discussion on the "Introduction of Syphilis," and other important topics are illustrated.

# PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

## CHEMICAL SOCIETY.—*Nov.* 3.

THE EFFECT OF IGNITION ON THE DENSITY OF MINERALS.—Professor Church related the results of a large number of experiments he had made to test the accuracy of some statements recently published in the *Transactions* of the Royal Society, maintaining that minerals of the garnet and idocrase family, after being expanded by heat, did not regain their original density for several weeks. In the *Transactions* it was stated that lime garnet having an original specific gravity of 3·35 was reduced to 2·98 by being heated to redness for a quarter of an hour, and being allowed to cool, and that the mineral regained its original density in one month. Professor Church denied the accuracy of these observations, and maintained that there was no "intermittent molecular change," idocrase, iron and lime garnets and olivine having nearly the same specific gravity after as before being heated, and not altering subsequently. Many minerals that undergo fusion at a high temperature he found to become permanently reduced in density. Thus a specimen of idocrase originally 3·40, was diminished to 2·937 by fusion, and a iron garnet from Arundel, originally 4·058, became reduced to 3·395, or even to 3·204 by long-continued fusion. These experiments of Professor Church accord with the results obtained by Magnus, who also found the densities of these minerals greatly reduced after fusion.

## ANTHROPOLOGICAL SOCIETY.—*Nov.* 12.

THE KINGDOM OF DAHOME.—Captain R. F. Burton described the present condition of the kingdom of Dahome, which he stated was one of eight purely negro races. Among the others are Ashantee and the kingdom of Benin, both of which are as inhuman in their worship as Dahome. In the Lake Regions of Central Africa is the kingdom of Karagwah; to the north, where the Lake Victoria Nyanza is supposed to lie, is a fine hilly country, inhabited by a superior race of negroes, who are ruled by a despotism which rivals in atrocity the most terrible despotisms of Western Africa. In Central Tropical Africa there is the great empire of Matiamoo, and in the south-east there is the country of the Muata Cazembra, in which two countries Captain Burton said nothing could be more horrible than the cruelties practised by the priests and kings. The great military kingdom of Dahome was first made known to Europe in 1724, and from that time it has been notorious for the brutal state of barbarism of its inhabitants, and for the cruelties of its kings, who do not, however, appear to surpass in that respect the rulers of the other kingdoms in Central Africa. There has been a great mixture of foreigners with original natives, and Captain Burton estimates that the only proper freemen with any remnant of ancient blood are

the members of the Royal Family, who number about two thousand. The Dahoman king is sworn never to lead his army where canoes may be required; therefore a neighbouring tribe, to protect themselves from his incursions, have built their huts upon tall poles, about a mile distant from the shore. These villages at once suggest the origin of the ancient lake dwellings of Switzerland. The Dahoman language is poor and meagre. It is harsh and explosive, the gutturals being most pronounced. About 300 words only are used in conversation, but the same word signifies very different things, according to the manner in which it is pronounced, which renders the language very perplexing. Captain Burton, in concluding his paper, observed that the dawn of the bright day when Africa will take her place in the republic of nations, appears wholly dependent on the light of the Crescent.

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## ROYAL GEOGRAPHICAL SOCIETY.—*Nov.* 14.

On the Sources of the Nile.—Captain R. F. Burton read a Paper on "Lake Tanganyika, Ptolemy's Western Lake-reservoir of the Nile." He commenced by acknowledging his recognition of the many noble qualities of Capt. Speke; his courage, energy, and perseverance. But he could not accept his "settlement" of the Nile. There were five objections to deriving the true Nile from the supposed Victoria Nyanza. 1, the difference of the levels in the upper and lower part of the lake; 2, the Mwerango River rising from the hills in the middle of the lake; 3, the road through the lake; 4, the inundation of the southern part of the lake for thirteen miles, when the low northern shore is never flooded; 5, the swelling of the lake during the dry periods of the Nile, and *vice versâ*. It might, however, be observed that, whilst refusing to accept the present settlement of the great problem, he in no wise proposed to settle the question: this must be left to time. Dr. Livingstone and Dr. Kirk, in their recent exploration of Lake Nyassa, threw remarkable light on the question, inasmuch as they had stated their convictions to be that no great river entered this lake from the north; the drainage of Lake Tanganyika, therefore, could not lie towards Lake Nyassa. Moreover, Dr. Kirk had informed the author that there was no community of species between the shells collected by Capt. Burton in Tanganyika and those collected by Dr. Kirk in Nyassa; and the "salt-weed" (*Potamogeton pectinatus*) found in Nyassa was unknown in Tanganyika. With regard to the effluence of the waters of Tanganyika in the opposite direction, namely, towards the Nile, Capt. Burton confessed that what he learned when on the lake in 1858 militated against the supposition of a northern outflow. The information received about the river connected with the southern end (River Marungu) was, however, quite positive to the effect that it entered the lake. Seeing now the difficulty of imagining a reservoir 250 miles long, situated at a considerable altitude in the zone of constant rains, without efflux, he was inclined to reconsider the question of an outflow to the north. The crescent-shaped "Mountains

of the Moon," which appeared in a sketch-map published by Capt. Speke, surrounding the northern end of Tanganyika, Capt. Burton showed to be a mere invention, and stated that in a later map of Speke's presented to the Society those mountains were no longer depicted. Many years ago Mr. Macqueen received from a native of Unyamwezi the statement, "it is well known by all the people there that the river which goes through Egypt takes its source from the lake;" and even Capt. Speke, on his return from his first journey, recorded that a respectable Arab trader had informed him that he saw a large river which he was certain flowed out of the northern end of the lake, for "he went so near its outlet that he could see and feel the outward drift of the water." Mr. W. S. W. Vaux has advanced the opinion that the drainage of Tanganyika is to the north, and Mr. John Hogg and Dr. Beke have also written to the same effect; Mr. Hogg pointing out that Tanganyika corresponded to the Zaire, or Zembre Lacus, or Western Lake-reservoir of Ptolemy. The level of Lake Tanganyika was given as only 1844 feet above the sea-level; this would be fatal to the supposition of its water falling into Lake Luta Nzigé and the Nile, if there were not great doubts of its correctness. The thermometer used in making the observations by the author and Capt. Speke was a most imperfect one, and liable to an error which would make a difference of 1000 feet. The levels of Victoria Nyanza, Luta Nzigé, and the Nile at Gondokoro, as given by Capt. Speke and Mr. Petherick, are also equally irreconcileable with the connexion of Victoria Nyanza with the Nile. The principal alterations which the author would introduce into Capt. Speke's map were as follows:—1. Draining Lake Tanganyika into the Luta Nzigé. 2. Converting the Nyanza into two, three, or a larger number of lakes. Captain Speke saw only 50 out of the 450 miles circumference of the lake; the rest was all hearsay, and, according to Speke himself, *Nyanza* meant equally a pond in the palace, a piece of water whether pond or river, and the Nile itself. He travelled in the conviction that the lake was on his right, but he never verified that conviction. Irungu of Uganda expressed to Speke surprise that the traveller should have come all the way round to Uganda when he could have taken the short and well-known route, *viâ* Masai-land and Usoga, which would be straight across the lake as depicted on Speke's maps. 3. Detaching from the Nyanza waters the Bahari-Ngo which drains the mass of highlands between the equator and 3° S. lat., and sends forth the Asua River, which the author believed, together with Miani and Dr. Peney, to be the trunk-stream of the White Nile. The author concluded by expressing his conviction that the "great Nile problem," so far from being "settled," was thrown farther from solution than before. The exploratory labours of years, perhaps of a whole generation, must be lavished before even a rough survey of the southern Nilotic basin can treat the subject with approximate correctness of detail. "Mais les sources du Nil, sont elles decouvertes?" inquires Malte-Brun. "Nous ne le croyons pas." No geographer does, no geographer can, believe in the actual "settlement" of the Nile sources. That the Tanganyika is the Western "top-head," not

source of the Great Nile, and that the Bahari-Ngo, which supplies the Tubiri, is the Eastern, I have little doubt. But the Arcanum Magnum of Old World geography has not yet been solved. It still remains to this generation, as to its forefathers, "Caput quærere Nili"—to close the canon of geographical discovery.

Dr. Livingstone wished to explain the use of the words Nyanza and Nyassa; both meant simply a piece of water. He had adopted "Nyassa" as the name of the Southern Great Lake, which he had explored, not because it was especially distinguished as such by the natives, but because it was convenient to give it a definite name. Last year he endeavoured to reach the northern end of this lake, to ascertain whether or not a large river entered it from the north, but was prevented from doing so by the hostility of a colony of Zulu Caffres there established. But he saw and heard enough to satisfy him that no great river entered at that point. Fifteen miles to the west of Nyassa stretched a high tract of table-land from which flowed numerous rivers, and one of these, after passing through two lakes, was said to enter Lake Tanganyika; but all this part of Africa still remained to be discovered. He saw no difficulty in a new expedition reaching this region, if they pushed quickly from the unhealthy low lands of the coast to the high lands, the exploration of which would soon decide the question of the water-shed of Central Africa.

Mr. Galton thought that the theory of a northern outlet to Lake Tanganyika had much to recommend it. The low altitude of 1844 feet, as taken by Captains Burton and Speke, need offer no difficulty, for the only instrument which they used was a common shilling thermometer. He did not think Captain Burton quite so fortunate in his theory about Victoria Nyanza not been continuous from Ukerewe to the Ripon Falls.

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## NOTES AND MEMORANDA.

The Magnesium Light.—*Cosmos* states that the apparatus for burning magnesium wire, contrived by Mr. Grant and improved by M. Leroux, involves an expenditure of thirty centimes (about 3d.) per minute, reckoning magnesium at the price of 1f. 20c. the gramme (15·432 grains). An ordinary photographic negative can be taken with its aid in 30 seconds, and an enlarged image obtained in from two to three minutes; and the writer reckons that even if three or four magnesium lights are employed, the expense would still be less than that of the electric light. Can this be correct with regard to the cheaper forms of electric light? For theatrical purposes he thinks magnesium will be valuable for brilliant illuminations of short duration, but that when they are required to last for a quarter of an hour the electric light will be cheaper.

Arctic and Alpine Vegetation.—A certain amount of success attends the comparison of the vegetation at given elevations, and at corresponding variations in latitude; but the distribution of heat is very different under the two conditions. Upon a mountain top in France or Switzerland the solar rays traverse a clear thin air, and strike vigorously upon the soil, which they heat considerably; while in such a neighbourhood as that of Spitzbergen the dense air intercepts a great deal of solar heat. From these facts we shall not be surprised

that Mr. Charles Martius found 131 phanerogams on the terminal cone of the Faulhorn, while only 93 have been discovered in the whole archipelago of Spitzbergen.

Arsenical Pigments and Health.—M. Pietra Santa has just communicated to the French Academy a paper on the possibility of avoiding injury to health through the employment of the arsenical green known as "Scheele's" and "Schweinfurth's." He states, as the results of six years' experience, that if the operatives wash their hands frequently, use warm baths, and change their occupation each week, they will not suffer from arsenical poisoning as a constitutional disease, and that any local injury will soon yield to the application of powdered calomel and salt water. When these precautions have been neglected in a lampshade factory, which he names, serious results have soon appeared.

Prolonged Sleep and Abstinence.—In a memoir by M. Blondet, read before the French Academy, there is a description of a lady, 24 years of age, who slept for forty days when she was 18, and for fifty days immediately after her marriage, when she was 20; four years later she went to sleep at Easter, 1862, and did not wake till the following spring in March, 1863, except on one occasion, eight days after the attack, when she took her place at the table, ate, and fell back asleep in her chair. M. Blondet occasionally introduced a little milk or broth by means of a machine. He describes her as a large handsome woman. He mentions two other cases in which prolonged sleep terminated in the cure of diseases, delirium (*délire générale*), and acute gastritis. He objects to the term "catalepsy" as conveying no scientific idea, and divides sleep into three kinds, diurnal, annual, and metamorphic, or of the chrysalis sort. The annual sleep, hybernation, he affirms not to be caused by want of food, or by the temperature alone, as hybernating animals will sleep in warm rooms with food beside them. He thinks that it may be a habit transmitted to certain creatures from very distant times, when the phenomenon may have been general and necessary to preserve life during violent winters.

The Relations between Functions and Organs.—When one set of physiologists declare that organs give rise to functions, and another set declare that functions produce organs, the latter do not mean that the functions can exist without the organ, but that the organ may be enlarged, diminished, or modified by the manner in which the function is performed. M. C. Sedillot discusses this question in *Comptes Rendus* (Nov. 13, 1864), and it is evident that the flexibility of organs may play an important part in modifying species. Amongst the illustrations he gives in support of the modifying influence of function, he says, "If a portion of one of the bones of the leg or fore arm be removed, and not replaced by growth, the associated bone enlarges till it attains a bulk equal to that of the two bones whose functions it is to perform. This phenomenon is very evident in dogs in which the tibia has been removed; the companion bone, which is almost filiform, and not one-fifth the size of the other, soon acquires equal or greater dimensions."

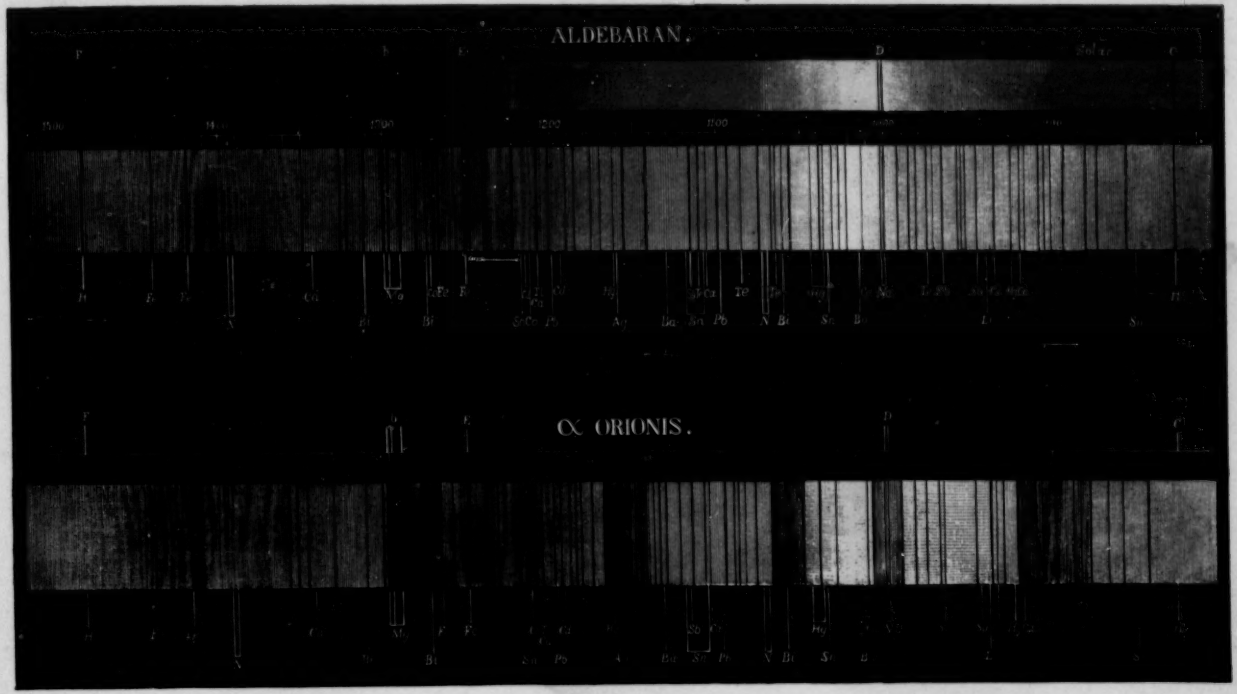
Effects of Elevation on Health.—*The Archives des Sciences* for October, 1864, contains an interesting paper by Dr. Lambard on the "Population of High Places," in which he reviews the writings of Dr. Jourdanet. At a height of 2000 metres, or about 6561 feet, the human body has only to support three-quarters of the atmospheric pressure experienced at the sea level. The quantity of oxygen taken in at each inspiration is greatly reduced, and evaporation facilitated. Debility, palpitation, neuralgia, and stomach disorder are encouraged by such conditions. The difference between the temperature in the sun and in the shade is greater than at lower levels, and at night the refrigeration is rapid and considerable. From this cause pneumonia is common, and has a tendency to terminate abruptly in stupor and loss of energy. In Mexico yellow fever does not reach a greater elevation than 800 or 850 metres. Intermittent fevers are rare, notwithstanding the presence of extensive lagunes; as the dry heat of the day and the cold of the night do not favour decomposition. Typhus and typhoid diseases are common in Anuhuac, and the dryness promotes inflammation of the pharynx. Rheumatism of the joints is common, and congestions of vital organs. Bronchial disorders and pneumonia are fatal to children; but pulmonary consumption, though

common on the hot dry coasts, is very rare on the plateau of Anahuac. Dr. Jourdanet thinks the diminished quantity of oxygen respired may cause this effect. The Mexican plateau does not agree with white races, who become weak, and would disappear if not constantly renewed from Europe. The aboriginal races disappear gradually in contact with civilization, but the half-breeds gradually increase, and seem able to resist the climate. The Swiss Association of Science has determined to investigate the effect of altitude on pulmonary consumption in Switzerland, and is about to issue circulars to medical practitioners in the high villages.

Camera Obscura for the Microscope.—Mr. E. Hinchcliffe writes to say that he takes a strong box, about a foot square, blackens it inside, and bores a hole at the top, through which he places the tube of his microscope inverted. The foot of his microscope is fixed to a square board, and a four-legged stand is placed on the top of the box for this board to rest upon. An ordinary lamp and the concave mirror he finds to give sufficient light, and the image is received and traced on a sheet of paper placed at a convenient distance from the eye-piece. A correspondent some time ago sent us a communication recommending the conversion of the *camera lucida* into a *camera obscura*, by turning the prism so that the image, instead of being reflected into the eye, was thrown down on paper. The objection to such plans is that they are only applicable to objects which are tolerably easy to draw, and which are displayed with ease under slight magnifications. Fine markings or delicate structures seen with high powers, and requiring careful illumination to bring them out, could not be dealt with in this manner.

The Habits of the Caplin.—In the *Transactions* of the Nova Scotia Institute of Natural Science, part i., vol. ii., is an interesting paper by Captain Hardy, on the fish called the caplin, which has been considered of the salmon family, of which it is the smallest member, being about seven inches long. Its scientific name is *Mallotus villosus*. It swarms on the coasts of Norway, Lapland, Iceland, Greenland, Newfoundland, etc. In the breeding season, but Captain Hardy thinks not at other times, the males have elevated ridges at their sides, composed of soft tumid elongated scales, having the appearance of rainbow-coloured velvet. The female is quite smooth. Captain Hardy has collected proofs of the statements originally made by Chappell, that at the breeding season the females, accompanied by a male on each side, rush on the sands, and the soft ridges of the males are employed in gently squeezing the female to expel the eggs. The caplin is considered essential to the cod fisheries, as no other known bait will tempt the cod in their swarming season. Captain Hardy is of opinion that the reckless destruction of the caplin for manure and other purposes will, if continued, ultimately ruin the fishery.

Habits of the Storm Petrel.—In the same publication we find observations on this bird by the Rev. John Ambrose. He visited the breeding places of the petrels on Green Island, about ten miles off land, in the mouth of Chester Bay. The petrels exhale a disagreeable odour, which he perceived at a distance of two miles from the island, and which he tells us a "gentle air" often carries to "Peggy's Cave," a distance of fifteen miles. The birds are nocturnal in that locality, and only seen abroad in day time in dull foggy weather. He landed at sunrise, and found them all in their holes underground, twittering like the squeaking of mice. "On taking a petrel out of its nest, it would not at first, on being set down, attempt to fly; but would endeavour to dig and shuffle its way into one of the broken holes." The nests are made in the angles of galleries, about six inches below the surface and parallel with it. Each nest has at least two ways of access to it. It is formed with a little dry grass, and kept very clean. The petrel uses its beak in these excavations like a pick-axe, and throws the loose earth behind it by kicking alternately with each foot. Mr. Anderson is convinced that the habit of the petrels of that district is to spend December, January, and February, somewhere more south, and to pass the greater part of that time at sea, near the Gulf Stream. They appear in their burrows on Green Island about the middle or latter part of April.




CELESTIAL CHEMISTRY
and
The Physical Constitution of the Stars and Nebulæ.